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STORAGE BATTERIES FOR ELECTRICAL TRACTION.

IN another column we reprint an abstract of a paper on storage batteries, read by Mr. G. A. Grindle, before the Manchester section of the Institution of Electrical Engineers. There is a great similarity between this paper and the article in our issue of January 25th, 1901, on the same subject, though the source of information and experience of the two authors are so different. Mr. Grindle writes, we believe, as one more or less interested in a well-known form of accumulator, whereas the author of the article—Mr. W. H. Booth—wrote from a conviction of the need of accumulators forced on him by a consideration of the statistics of fuel consumption and energy output of numerous stations having a widely different load factor. Mr. Grindle assumes a typical load factor of 33⅓ per cent., whereas that taken in our article was 25 per cent. for a small station. Mr. Grindle allows 20 running cars, for which number the load factor would be 32½ per cent. by the formula of our contributor. Both writers are thus in agreement as to the figures, but Mr. Grindle takes a system of 20 running cars requiring 150 KW. for mean output, whereas the output assumed by our contributor was 37½ KW. only. An ordinary English system with 20 running cars would, however, not consume the average of 7½ KW. allowed by Mr. Grindle. About 12 amperes or 6 KW. at 500 volts would be ample to allow. The only material difference between the figures of January 25th and those now advanced by Mr. Grindle is in the cost of the batteries, which Mr. Grindle assumes at £12 per kilowatt, whereas they appear at £22 in the ELECTRICAL REVIEW.

It is, perhaps, natural that Mr. Grindle should produce a more favourable estimate for batteries than what is allowed by an engineer who, no doubt, wrote from the standpoint of the station engineer; but in the conclusion of Mr. Booth's article we find that from information acquired in Germany, he modifies his figures to the extent of reducing the battery costs to £13·2 per kilowatt of output, so that here also Mr. Grindle's figures are practically identical with those advanced in the REVIEW.

Mr. Grindle, however, goes more fully into the question of the arrangement of the cells relative to the line and power generator. He objects to the buffer arrangement suggested in Mr. Booth's article, because it requires a careful predetermination of the characteristic of the generator. This is hardly a ground for objection. It is the business of makers of dynamos to do these things, though we must confess some of them appear to leave such matters to mere chance.

In the sub-station system, where the battery is simply placed across the mains, the action of the battery is entirely dependent upon the voltage variation in the line. This, of course, drops with the heavy loads and enables the cells to discharge. It is probable that where the copper in a line is insufficient to carry current without an excessive drop in the

voltage, such a system might work well, but it hardly appears sound to depend for success upon a fault that should be removed in any case. Mr. Grindle says that in a number of cases he has known batteries thus connected to lie dead on the line, and cites an instance where a battery of 175 amperes discharge never gave more than 40 when placed in a sub-station—a compliment, we should say, to the efficiency of the cable system.

Where a part of a battery is employed in the shape of regulating cells, either in the case of a battery installed at a power station or at a sub-station, the general result has been, says the author, the conspicuous failure that we should anticipate. It is also expensive, owing to costly leads and switch gear, and the regulating cells deteriorate rapidly. Mr. Grindle, therefore, condemns this system as well as the others named, and falls back on the system of charging the battery by boosted current for a definite period and putting it across the line either with or without regulating cells at times of heavy load. But this does not satisfy him, as the work is heavy on the battery, and the system has no special advantage to recommend it. He finally recommends a differential or reversible booster, whether for a battery at the station or outlying sub-station. By this he means that in series with the battery there is a variable-field booster, the field being automatically controlled by the battery pressure, and the booster pressure varies exactly as the battery pressure departs from the desired constant value, so that the pressure across the combined terminals is constant perfectly. The battery, we are told, will take care of the entire variation of load above or below normal, the generator thus working at a constant load. There must be the same drop of the line voltage as on the buffer system to enable the battery to discharge, but there is, of course, the advantage that the battery can be worked over wider limits by means of the booster when the main generator is at work, and a steadier pressure maintained in the line. Experience of the two systems can alone show which proves the most satisfactory in practice. The buffer system is the more simple, while the booster system adds to the complications that are already too numerous in electrical work. As so large a current is demanded from the battery, the booster will be of considerable size. It is described as a triple machine, consisting of a motor, a generator, and an exciting controller.

As regards the engine, Mr. Grindle again becomes an echo of our contributor when he calls for one to work at constant admission and pressure, but if he is well versed in steam engineering he could hardly say anything else, because the use of a battery is to enable just such a desirable end to be secured.

We note that Mr. Grindle is one of those who stand in awe of the "violent stresses" in traction work due to sudden load variation. We thought this fallacy had been exploded. He is wrong also in what he says of voltage variation due to sluggish governing. A good fly-wheel governor responds quickly enough to deny this belief. In all he says of the possibility of using a small engine he is quite correct. This possibility is the sole excuse for battery traction, otherwise the inevitable loss in the battery would be uselessly shouldered. Everything points to the advantage of the power station. In fact, the whole question simmers down to one of outlay. If the additional plant costs less or not much more than the plant saved, the working expenses may be very considerably reduced.

The fuel consumption of steam engines on traction work has been stated by Mr. W. H. Booth as approximately inversely as the load factor, and on this fact he based the plea that the overhead line and distribution system should be of the best possible description of work and materials, in order to justify the largest possible electrical homogeneity; that it was an economic error to separate the different feeders of a system, because, by so doing, the load factor of the separate sections is reduced so much below that possible when the whole are placed in electrical continuity. Where batteries are employed this continuity is not necessary, because the engine load is constant in any case. Everything now turns on the durability of a battery. It is necessary that a fair commercial profit be shown after suitable interest and depreciation charges have been met.

The Companies' Act of 1900 in Operation.—The case of Burrows *v.* the Matabele Gold Reefs and Estate Company, Limited, affords an interesting illustration of the effect of the Companies' Act, 1900, the more important provisions of which were dealt with in a series of articles in these columns at the commencement of the present year. The defendant company was incorporated in March, 1899, with a capital of £500,000 in £1 shares, of which £387,030 have been issued. Wishing to issue £80,000 more capital, the directors on February 1st, 1901, issued a circular to existing shareholders offering them an allotment of one share of the new issue at a premium of £2 10s. in respect of every five original shares. To secure this issue the directors entered into an underwriting agreement whereby they sought to have 60,000 shares underwritten. They offered the shares to the underwriters at the same premium—*i.e.*, £2 10s. per share. The plaintiff, on behalf of himself and all other shareholders in the company, brought an action to restrain the defendant company from applying or agreeing to apply any of its shares or capital money, directly or indirectly, in the payment of a commission or allowance to the underwriters. He based his claim for the most part on Sec. 8 of the Companies' Act, 1900, which provides that the amount of underwriting commission payable must be authorised by the articles and disclosed in the prospectus, otherwise no company

> Shall apply any of its shares or capital money either directly or indirectly in payment of any commission, discount, or allowance, to any person in consideration of his subscribing or agreeing to subscribe, whether absolutely or conditionally, for any shares of the company, or procuring or agreeing to procure subscriptions, whether absolute or conditional, for any shares in the company, whether the shares or money be so applied by being added to the purchase money of any property acquired by the company or to the contract price of any work to be executed for the company, or the money be paid out of the nominal purchase money or contract price, or otherwise.

It was argued by the plaintiff that an allotment of shares under the underwriting agreement would be an application direct or indirect of shares in payment of commission, discount, or allowance to persons in consideration of underwriting. Mr. Justice Farwell held that this contention was sound, and granted the necessary injunction. The company endeavoured to escape from the mesh by saying that the section in question only applied to underwriting of shares for public subscription, and that the Act was intended to protect that portion of the public only who had not yet become members of a company. The learned judge rejected both of these contentions, saying that the Act was intended to protect existing as well as prospective members of limited liability companies. This case, in which there was no suggestion that the underwriting agreement was anything but *bonâ fide*, serves to show the far-reaching effect of the new measure. It would seem that unless provision for the payment of commission is made in the prospectus, the directors may find it difficult to make any new issue of shares unless they are certain that the same will be promptly taken up. Where a prosperous trading concern is turned into a company, there is little need for underwriting on the first issue of shares; but where for some reason the prosperity of the company depends upon fresh capitalisation, the public are not always so ready to come up to scratch.

THE GENERATION AND TRANSMISSION OF ELECTRIC ENERGY AT AND FROM COAL PIT CENTRES.

By B. H. THWAITE, C.E.

(*Continued from page* 354.)

One of the most remarkable examples of American enterprise is the electrical transmission installation of the Telluride Transmission Company, at Provo, Utah.

The generating plant consists of two 750-kw. three-phase alternating generators directly coupled to turbines running at 300 revolutions, with 60 frequency and 800 volts winding pressure. The step-up transformers, each of 250 kw. capacity, are set up in the star formation, with the neutral points of both primary and secondary grounded.

The line, transmitting energy at a pressure of 40,000 volts, passes through a mountainous region 10,000 ft. above the sea level. The transmitting line distance is over 55 miles in length. The insulators, 7 in. diameter, are of glass. The power is utilised for driving milling machinery. The plant has been in commercial operation for more than two years, and has worked remarkably well.

A similar installation of the Southern Californian Power Company transmits electric energy over a distance of 80 miles, the normal line pressure equalling 33,000 volts. The generating equipment consists of four 750-kw. generators, driven by impulse water-wheels.

Examples of Modern Long-Distance Electrical Transmission Plants in United States and North America of 1,000 kw. and over.

All three-phase.

Title of company and locality.	Capacity kw.	Length of conductor line. Miles.	Electrical pressure. Volts.	Frequency.
Redlands Elec. Light and Power Company, Redlands, Colorado ...	1,000	21	10,000	50
Sacramento Elec. Co., Folsom, California... ...	3,000	22·5	11,000	60
San Joaquin Elec. Co., Fresno, California ...	1,050	{ 55 35	11,000 19,000	60 60
Big Cottonwood Power Co., Salt Lake City, Utah ...	2,000	14	10,000	60
Pioneer Elec. Power Co., Ogden, Utah	3,750	40	26,000	60
Rawhide Gold Mining Co., Jamestown, California	1,125	15	15,000	66
St. Anthony's Falls Water-Power Co., Minneapolis, Minn.	5,600	10	12,000	35
Telluride Power Transmission Co., Provo, Utah ...	1,500	55	40,000	60
Colorado Springs, Colorado	1,400	25	20,000	30
Hudson River Power Transmission Co., N.Y.	3,750	18	12,000	38
Montano Power Co., Butts City, Montano	3,000	21	{ 15,000 26,000 }	60
Salt Lake City Elec. Power Co., Utah, U.S.	1,000	—	16,000	66
Southern Californian Power Co., Redlands, California	3,000	80	33,000	50
St. Croix Power Plant, Apple River, Wisconsin	750	27	25,000	60*

* This St. Croix installation, recently completed, transmits energy at 25,000 volts—through aerial conductors—24 miles long, and the same energy is transmitted underground at the same pressure for 3½ miles—the line has been successfully tested to 30,400 volts. The three-phase generator has a pressure of 800 volts, 60 frequency, and runs at 300 revolutions (three-wire transmission).

This record is admittedly a splendid example of American enterprise; the applications have not up to quite recently included the generation of the power at the coal pits, but we have not had to wait long for an example.

Unfortunately, the American coal-pit project, like that in the Rand, is imperfect, including, as it does, the generation of steam-power instead of utilising direct combustion of fuel in internal combustion engines, which should, for land purposes, be the basis of all fuel power.

The American example of coal-pit electric power transmission consists of an installation in course of construction at two coal pits respectively 4 and 3½ miles from the town of Colorado Springs; one of the economic reasons for this application is the fact that the cost of carriage of fuel is high (this *raison d'être* also exists throughout Great Britain, where the railway rates are at least three to four times greater than they are on the most important trunk lines in the United States). At one of the collieries 2,000 h.p. are being installed, made up of directly coupled Corliss engines, driving two 1,000-kw. three-phase alternate-current machines, 21 ft. diameter, running at 90 revolutions per minute. Each alternator has 80 poles. The line pressure is 6,600 volts.

In addition to supplying the town of Colorado Springs, the coal-pit power station will electrically supply a mill, distant some 7 miles from the coal pit. The transmission line will be laid from the pit to the town of Colorado Springs, and from the latter to the mill, and directly also from the coal pit to the mill. The motors will be of the synchronous alternating type, independently excited. At the mill the excitation machines are to be driven by three three-phase induction machines, that are both self-starting and self-exciting.

The second colliery equipment consists of two duplicate design Allis-Corliss engines, driving two 500-h.p. two-phase generators, running at 100 revolutions.

The list of long-distance applications has been purposely, and as far as possible, limited to the three-phase types—because the finger post points to this phase—as the one that forms part of the formula which is asserting itself as the most economic and the most perfect.

In America the three-phase leads the way, the two-phase follows at a great distance, the monophase being practically nowhere. In Europe the supremacy of the three-phase is still more conspicuous, the relation of position being in the following ratio:—Triphase = 300, biphase = 100, monophase = 10.*

Before referring in broad detail to some modern European transmission applications, two more examples of transmission projects in the United States can be instanced; the first one is a good example of monophase work:—

At San Antonia Canon, California, electric energy for lighting purposes. In one instance the energy is transmitted for a distance of 16, and in another 28 miles. The pressure of the electric generators of 1,000 initial voltage, is raised to 10,000 volts in the line. The electric generator has an output capacity of 150 kw. The line is of bare copper carried by insulators, 7 in. diameter, of the petticoat form, and without oil troughs.

At Guadalajara, Mexico, there is an 18-mile transmission installation, with a line pressure of 5,000 volts.

The trend of practice in the United States for supplying energy for railway and tramway systems, is decidedly polyphasic, with step-down transformers and rotary converters at the sub-stations. A 70,000-h.p. plant of this kind is being installed in New York.

European examples of long-distance transmission may now be given:—

Prag-Stuttgart.—Electric energy is now being transmitted a distance of 21 kilometres from a waterfall near Marbach. The generating complement is made up of four turbines of 337-h.p. each. Each turbine actuates by conical wheel driving, a three-phase alternator of 220 kw. at a pressure of 10,000 volts. The excitation of each alternator is provided by continuous current machines coupled to three-phase synchronous motors. The current for the motors is derived from two transformers that reduce the pressure from 10,000 to 110 volts. An excitation auxiliary is provided by

* The following summary of examples of three-phase alternating applications for purely manufacturing industrial work represents the eight years' work of a single Continental firm:—Three-phase generators for producing calcium carbide, with an output capacity of 40,000 kw.; ditto, driving the spinning and weaving machinery of cotton and silk factories, with an output capacity of 14,800 kw.; ditto, applied to the iron and steel industries, including the driving of rolling and tube mills, with an output capacity of 2,220 kw. In pumping stations, 7,200 kw. capacity: in mining machinery, 6,200 kw. capacity; in sugar refining, 340 kw.; in conveying and lifting machinery, 1,860 kw. capacity; in rifle factory, 80 kw. capacity; in operating bridges, 150 kw. capacity.

means of a battery of accumulators. The energy is transmitted from the primary generating station to the step-down transforming station on the Prag, near Stuttgart, by means of six overhead conductors.

The transforming station had its origin in the necessity of transmitting the current underground from this station, and it was *considered altogether impracticable* to transmit the energy at the high pressure of 10,000 volts by underground lines.

In the Prag step-down transformer station the pressure is consequently reduced to 300 volts, an equipment of three transformers, each of 200 KW. being provided; at this pressure, 300 volts, the energy is transmitted underground to the Stuttgart electricity supply sub-station, situated at Stuckach; here a part of the energy is transformed from the alternating into continuous by means of two rotary transformers, each of 110 KW. The supply is distributed for lighting and power purposes, including, in the latter category, a supply for tramways.

The balance of the energy—three-phasic—is transmitted to the central electricity supply station at Stuttgart, where it is reduced in pressure and transformed into continuous current to satisfy the existing requirements of the electricity supply and distributing mains of Stuttgart. The transformation to continuous current is effected by means of three transformers, each of 180 KW. capacity.

Vizzola, Lombardy.—Another most interesting example of long-distance transmission work, and one offering a precedent for imitation in our textile districts of Lancashire and Yorkshire, is that of the Lancashire of Italy—Lombardy—and its textile centres of Legnano-Saronna, Busto, Arsigio, Gallarate. The electric force is generated at the Vizzola Waterfall, fed by the River Picimo. The hydraulic fall equals 28 metres, and drives 10 turbines, each of 2,500 H.P., directly actuating three-phase alternators with pressures of 12,000 volts. The energy is transmitted to various locales of power distribution by means of 36 bare copper cables, which are supported by lofty masts, the degrees of transformation within the limits of 110 to 550 depending upon the power customer's wishes.

Paderno, Milan.—This installation is interesting as a pioneer example of high pressure winding. The three-phase alternators generate current direct at 15,000 volts without any intervening assistance from transformers. Views of the generating station of Paderno, Milan, showing four 2,200-H.P. 15,000 volts three-phase generators, appeared in the ELECTRICAL REVIEW, October 5th, 1900. The oil switching gear of the Paderno central station (by means of which it is possible to safely and reliably switch out a fully loaded 2,200-H.P. generator under the exceptionally high pressure of 15,000 volts) is a considerable triumph in electro-technics. This oil switching-out gear has often been operated with a fully loaded generator under a test pressure of no less than 20,000 volts, and always in a certain and effective manner.

Stallegg, Donaueschingen.—This three-phase alternating long-distance transmission installation is deserving of the title of pioneer. It has actually been in operation since the year 1895. The generation of electrical energy is effected at Stallegg; here is installed a three-phase alternator of 150 KW. at a pressure of 150 volts. This alternator is actuated by a turbine driven by the flow of water diverted from the River Wulach.

The line pressure is raised to 10,000 volts by means of two 75-KW. transformers, and is from them transmitted 25 kilometres to Donaueschingen. Here the line pressure is reduced to 150 volts, and is then converted to continuous current at 250 volts by means of a Schuckert rotary transformer having a single armature. The distribution of the continuous current over the customer's area is effected on the three-wire system.

With the object of assisting the continuous current supply and to permit the regulation of the voltage, the station is equipped with an accumulator battery, which is charged with boosters.

(*To be continued.*)

Amsterdam.—The City Council, according to *Commercial Intelligence*, recently voted a sum of nearly £500,000 for electric lighting and traction purposes.

THE ECONOMICAL CURRENT DENSITY FOR SMALL CONDUCTORS.

By JAMES WHITCHER.

(*Concluded from page* 362.)

THE application of the law in the case now to be discussed is rather less complex than in that above mentioned. Briefly stated, the law asserts that the minimum total cost of the conduction of electrical energy is secured when the conditions are so adjusted to each other that two of the distinctive parts making up the sum of that total cost, viz., that part of the capital charges which is directly proportional to the sectional area of the conductor, and the cost of the wastage of energy, shall be equal. To get a thorough mathematical grasp of the problem involved in selecting the most economically efficient conductor for a given purpose, we must first of all secure a complete understanding of what are the quantities involved.

The total annual cost of the conduction of electrical energy through a given conductor, is made up of the annual value of the wastage of energy in the conductor arising from its resistance, and the capital charges, *i.e.*, the interest, maintenance, and the depreciation or amortisation, usually calculated on the capital investment in the conductor. But we must not be hasty in our estimation of what these two items actually are. The meaning of them is very much more complex than the young and thoughtless formula ferret is apt to suppose.

It will save time and space if we get our ideas into a suit of symbols at once, and possibly they will be the better for some decent clothing of that sort. Certainly we want them to be recognised as something more than *bare* ideas. We have to deal during the course of our argument with quantities as grouped and designated in the list below:—

A = total annual cost in £ of conducting a given current for given time.
P = prime cost in £ per mile run of conductor fixed.
S = sum of rates per cent. per annum of interest, maintenance, and depreciation charges on same.
D = the economical current density in amperes per square inch.
C = current in conductor in amperes.
a = sectional area of conductor in square inches.
0·045 = resistance of 1 mile of 1 square inch copper conductor laid.
v = value of energy wasted in pence per KW.-hour.

The price, P, is, of course, proportional to the sectional area, a, but not directly so. To find out how it varies with a, we must take the costs of several adjacent sizes of conductors insulated in the way desired, and add the cost of casing, tube or armouring and of labour of fixing. It will then appear, that nearly enough for all practical purposes, P is made up of a part strictly and simply proportional to a, and another part quite independent of it; *i.e.*, it would apparently remain, although the area be indefinitely diminished. Or say, $P = p\,a + q$ where p and q are constants; the values of these depend on the class of insulation and protection, and we shall examine them later on.

The rates, S, must, of course, include interest or the amount the money invested in mains would bring in, if used to influence income, say, 3 per cent; maintenance or repair costs, which, in the case of house wiring, are very small in a direct sense. but their presence increases the expense of general repairs and alterations, so that for this we should add, say, 1 per cent.; and depreciation or, better, amortisation, to provide for the wiring becoming valueless to the original owner, due either to decay or forced sale or like changes. The last is the most important item; being a fixture and not easily negotiable, wiring property must not be regarded as having a very long life of usefulness to the first proprietor of it. Allowing it 21 years and taking the value of money at 3½ per cent. we find that about £6·5 per annum for 21 years is equivalent to a present value of £100—*i.e.*, the amortisation rate is 6½ per cent., minus 3 per cent. already charged as interest. Therefore the sum S is about 7½ per cent.

The value v of the wasted energy is fixed and definite if it is bought by meter and charged accordingly, but if generated by one's own plant it is doubtful how to rate it. At light loads it has scarcely any worth at all, for if wiped out entirely no appreciable saving would be realised. It is generally so insignificant a part of the total load that it seems pedantic to saddle it at any time with its proportion of generation labour and capital charges, which weigh so heavily on the cost of the useful unit. Yet, strictly speaking, it has its influence on the size of plant, so that supposing we have a loss of 4 per cent. in mains at full load, then 4 per cent. of those generation capital and labour charges that are proportional to the output should be debited against the mains, a loss which could be avoided by increasing the size of mains. This point was treated more fully in the paper already mentioned.

Equating A to a minimum for the simple case in which the current is taken from a public supply at a constant price, v pence per unit, we have for a continuous use of current, C, for n hours per annum :—

$$A = 0{\cdot}0000001875\ v\ C^2\frac{n}{a} + 0{\cdot}01\ s\ (p\ a + q) \quad (1)$$

$$\frac{d\,A}{d\,a} = 0 = 0{\cdot}01\ \left\{ s\ p - 0{\cdot}00001875\ v\ n\ \frac{C^2}{a^2} \right\} \quad (2)$$

Or the first term of the sum for A should equal the second minus the constant q, which is the Kelvin law.

$$\text{Also } D = \frac{C}{a} = 400\ \sqrt{s\ p/3\ v\ n}. \quad (3)$$

Now the value of s is about $7\frac{1}{2}$ per cent., as determined above ; that of p is about 2,400 for the smaller conductors in high-class wiring systems, and 2,000 for the large mains. We will take v as 4d. per unit. The value of n is, of course, very variable, and it is a complicated calculation to decide it ; for a given conductor is passing full load for a very short time, and when working at fractions of full load the loss in an hour is only equal to the square of the fraction of what it would be at full load. Thus at half load the loss in one hour would be equivalent only to the full load loss in one quarter of an hour. Since n is the equivalent number of hours per annum at full load from the point of view of loss, it is really much smaller than usually supposed. In fact, the writer, in some cases, would feel justified in taking it as low as 200 hours per annum. The full discussion of these points is impossible in the scope of the present paper, which is already too long. But they are worth the reader's working out for his private delectation.

With the values given substituted in Equation 3, we have :—

For wires $D_1 = 4{,}000\sqrt{\frac{15}{n}}$.

For mains $D_2 = 20{,}000\sqrt{\frac{1}{2\,n}}$, so that when :—

n =	200	300	400	500	600	800	1,000
D_1 =	1,095	892	775	692	632	547	490
D_2 =	1,000	800	700	632	575	500	450

Since n is usually greater for the small wires than for the main cables, a rough, all-round average for the economical density in general wiring work is between 700 and 800 amperes per square inch. For private generating plant v will be somewhere about 3d. per unit, whence the said rough average becomes 800 to 900 amperes per square inch.

At 800 density the voltage drop is, of course, 4 volts per 100 yards run of lead and return. The logical way of making concessions to the need of regulation in any given installation, is to run up the density of the shorter circuits of the system to balance a corresponding reduction of it on the longer circuits, the average all round remaining near the economical density. Of course, this cannot be taken too far ; but certainly no obstacles should be put in the way of going right up to the safe heating limits, such as, for instance, are stated in the Institution of Electrical Engineers' rules.

What we are pleading for is more reasonable latitude, and liberty to work on sound commercial lines. It is scarcely worthy of the dignity of the trade, that any young cub, knocking about with a voltmeter, can give an authoritative damning to what is actually an honest intelligent job, carried out on the best and truest principles, and bring plenty of chapter and verse of weighty names to support his insufferable pretensions. But so he can do ; and thus we have to regulate our electrical ways by a sort of religion that cometh out of the mouths of our babes and sucklings, bubbling ever fresh and sweet, and innocent of life's struggle's guile. There are many of them doing much the same thing with an ohmmeter or Wheatstone bridge ; but that is another story.

HIGH TENSION CABLES.

By E. KILBURN SCOTT.

Mr. Fynn's article on "The Development of Three-Phase Working in the Twentieth Century" in the Electrical Review for February 1st is interesting reading, and I note that he has thrown into relief the difficulty of working cables at high voltages. He says :—

> Supposing that overhead transmission was permitted in England, I doubt whether our climate would allow of the adoption of much above 15,000 volts.
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> Quite apart from the question of whether overhead transmission at such pressures is tolerated in a country's laws or not, we must consider whether it is justifiable or not. Such tensions naturally imply great distances ; it is, of course, impossible to supervise such lengths of line, and it must consequently be admitted that as soon as the line comes within easy distance of populated districts it becomes impossible. We are thus forced into one of the most difficult points to be answered. We must have recourse to cables. To my knowledge the highest pressure which has yet been transmitted by cables to any appreciable distance is well under 15,000 volts.
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> Will it be possible to manufacture cables which will carry currents at pressures up to 30,000 volts, such as will surely be required to give full and remunerative scope to the three-phase system in the coming century ?

As cables are usually made, 15,000 volts is well over the limit, but fortunately a method—the Brooks semi-solid system—has been in use for many years, which appears to meet the case very well.

Like many other valuable ideas, the self-healing oil-insulated cable was years before its time, for at pressures of a few thousand volts only there is not much call for such a special method. At extra high voltages, however, it is not so much a question of expense or trouble as of finding some method which will fulfil all the conditions satisfactorily. Let us consider for a moment the special features of the oil-insulated cable.

The cables are covered with jute braiding, and are then drawn into an oil-tight conduit into which the oil is poured at about 300° F. When cold the oil is of the consistency of india-rubber solution, and should a fault occur the temporary current warms up the oil locally, making it run readily, and so automatically seal the fault. Boiled resin oil is used, and as it is heavier than water any moisture which remains in the tube rises to the surface, the cable, of course, sinking to the bottom.

It might be thought that the jute covering would hold a certain amount of air and moisture, but the process of manufacture is so carefully carried out that this is practically impossible. The method adopted is to place the covered cables in a vacuum chamber connected with a condenser, and keep it there until practically a perfect vacuum is obtained. The cock for the oil is then opened and the boiling oil rushes in and thoroughly impregnates the jute. The oil has been previously boiled for many hours, and everything that rises to the surface carefully skimmed off. Any tendency to develop organic acids by increase of temperature is neutralised by the addition of a small quantity of lime to the oil before it is placed in the conduit.

The tube is sealed, so there is no available space for the accumulation of ammoniacal or other gases, and in case of a leak all that happens is that a small portion of the insulation

oozes out, and becoming hardened by contact with the atmosphere, seals up the leak. A head of oil is provided at the highest point of the system to make up such leaks. The risk in drawing in ordinary insulated cable, *particularly if paper insulated*, is very great, whereas in the semi-solid system the insulation is added after the cables are *in situ*, and so they can be drawn in and out with impunity. If a measurement is required all that one has to do is to push a knife through the insulation at any joint box and so get connection on to the copper. On withdrawing the connection, oil runs in and the insulation is as good as before.

Experience at Chatham and Rochester, Hong Kong, Glasgow, Keswick, Worcester and other places where this method is used, has shown that it differs from all others in giving practically constant insulation. The cable may be struck by lightning, and yet the self-healing property is so effective that immediately afterwards it is impossible to detect any fault or weakness. This has actually occurred at Chatham and New Jersey.

Homogeneity of the insulation has been shown to be a feature of great importance in cable manufacture, and there can be no question that in this respect semi-solid oil is far before all other methods. If temporarily overloaded, the oil becomes more liquid, which is an advantage, because it helps to keep up the homegeneity, and therefore, if anything, improves the insulation. With india-rubber cables, on the other hand, the heat may over-vulcanise and so do harm.

So long ago as 1892, in his lecture at the Royal Institution, Tesla said :—

> A main conveying alternating currents of very high tension may be injured merely by a blow-hole or small crack in the insulation, the more so as a blow-hole is apt to contain gas at low pressure; and as oil appears to completely obviate such little imperfections, I am led to believe that in our future distributions of electrical energy by currents of very high tension, semi-solid insulation will be used.

Those who advocate the oil-insulated system for extra high tensions are, therefore, in pretty good company.

There is no doubt that for the proposed power distribution schemes over extended areas and the working of main line railways, &c., the question of the high tension cables is the most ticklish part of the work, for it seems certain that we shall be debarred from using aerial conductors as on the Continent and in America.

The following paragraphs are taken from the Board of Trade regulations (under the Electric Lighting Acts, 1882 and 1888) for securing the safety of the public :—

> 9. *High Pressure Conductors to be Covered.*—Every high pressure conductor laid after the date of these regulations shall be continuously covered with insulating material to a thickness of not less than one-tenth part of an inch, and in cases where the extreme difference of potential in the circuit exceeds 2,000 volts, the thickness of insulating material shall not be less in inches or parts of an inch than the number obtained by dividing the number expressing the volts by 20,000.
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> 10. *Testing of Insulation of all parts of any High Pressure Circuit.*—A high pressure circuit shall not be brought into use unless the insulation of every part thereof has withstood the continuous application, during one hour, of pressure exceeding the maximum pressure to which it is intended to be subjected in use—that is to say, in the case of every electric line a pressure twice the said maximum pressure, and in the case of every machine, device or apparatus, a pressure 50 per cent. greater than the said maximum pressure.
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> 13. *Limit of Power in High Pressure Electric Lines.*—A high pressure electric line shall not be used for the transmission of more than 300,000 watts, or in the case of an aerial line, 50,000 watts, except with the consent in writing of the Board of Trade, and efficient means shall be provided to prevent this limit being at any time exceeded.

Let us suppose that a conductor ½ in. diameter, say 19/15, has to transmit power at 30,000 volts, and it is proposed to use paper insulation. According to Regulation No. 9 above, the insulation must be

$$\frac{30{,}000}{20{,}000} = 1\tfrac{1}{2} \text{ in. thick.}$$

Therefore the diameter overall comes out at 3½ ins., and this requires a lead sheath ¼ in. thick. Consider for a moment the enormous expense of such a cable, when the lead alone weighs 36 tons, and costs £600 per mile run. As one yard of the cable weighs nearly 70 lbs., it could not be conveniently manufactured and hauled in lengths greater than 50 yards or 1½ tons weight; this, of course, means an enormous number of drums and joint boxes. Then again, there is the lopping on of the paper. A cable for 3,000 volts having ·15 in. radial depth of paper requires to be put through the covering machine three times (this is with paper strip ·005 in. thick); therefore, to insulate to 1·5 in. the cable must go through 30 times. Even if thicker paper is used and the number is reduced to 20 times, imagine the enormous labour charges that would be incurred. It may be said that the number of "heads" on the covering machines could be increased; this might be done, of course, but even with three heads, as is the usual practice, such machines run to very great lengths.

It should be remembered in this connection that the labour charge on a cable does not vary with the voltage; thus, if a cable for 5,000 volts costs, say, £1,000 per mile, the price of a similar cable for 30,000 volts would be much more than $\frac{30{,}000 \times 1{,}000}{5{,}000}$, *i.e.*, more than £6,000.

The entirely solid system, that is to say, laying an insulated and possibly a lead-covered cable in a metal or pot conduit, and filling in solid with bitumen, is very good, but it has the disadvantage that the cables cannot be drawn in and out. The writer takes it, that the idea of the solid bitumen is not so much to add further insulation as to preserve the cable from gas and moisture, &c. However it may be refined, bitumen cannot be put forward as a substitute for the rosin oil insulation of the semi-solid system.

This bitumen system strikes the writer as being preferable in many ways to paper insulation alone, but at the same time, the method which comes nearest perfection must obviously be a drawing-in system. The constant opening up of our roads is a terrible nuisance, and only by adopting drawing in can this be prevented.

It may be interesting to consider for a moment what would be the probable effects of overheating the various kinds of insulation.

With rubber the insulation would over-vulcanise and tend to crack and shrivel up. Pure Para rubber is put next to the conductor, mainly to improve the insulation, but also to guard the conductor from the sulphur in the vulcanised rubber behind. The copper wires are also tinned with this object, as well as to facilitate jointing.

With insulation in the form of Manilla paper the copper wires do not need to be tinned, as no sulphur is present and there are no chemicals in the fibre to attack the copper. The effect of over-heat would be to dry up the rosin oil and then to render the paper powdery and unfit for use, as happens in transformers, &c.

Now in the case of the *oil insulation* only, the heat would simply make the oil more liquid round the conductor, for it would take a tremendous amount of heat energy to liquify the oil right through. There is, therefore, no chance of acids forming by undue rise of temperature; in any case, it is easy to add to, or entirely renew, the oil should it be necessary. The jute which is used for the semi-solid system weighs 13 to 26 ozs. per 1,000 yards, and as it is spun very loosely, the various threads run into each other much better than would be the case with clean cotton fibre.

Objections are sometimes made that the Brooks system is not suitable for hilly districts, but as a matter of fact, Chatham, where the system has been in successful operation for years, is particularly undulating.

It may be thought that the semi-solid system must necessarily be carried in iron pipes. This, however, does not at all follow. Stoneware pipes ⅝ in. thick made from the Poole clays of Devonshire will give ample strength when buried 2 ft. deep. They are only about half the cost of iron, and there is no reason why stoneware joint boxes could not be used as well. Three-way stoneware pipes can now be bought very cheaply, which are made specially for the purpose. The pipes are 2½ or 3 ft. long, and are jointed with composition.

It must be remembered that the tube of the semi-solid system is filled up solid with oil, and it is therefore much stronger than if it were hollow. Stoneware has the further advantage for high tension work that it is itself a fair insulator. However well coated with preservative compound,

metal tubes are always liable to attack by acids in the ground. On this account it seems to the writer to be quite a mistake for a municipality or other body who can afford to do things properly, to lay lead-covered and armoured cables direct in the earth, for the much-used phrase "neutral earth" is a glib term which is practically meaningless. For example, it is quite impossible to guarantee that the earth will remain the same, and again, the cable may go through some made ground in which there is a percentage of ashes, the sulphur in which will undoubtedly in time attack the steel. Naturally, directly the lead and steel form a couple, the cable is done for.

It may be interesting to note that mere change of temperature is quite enough to set up chemical action; for example, a cable may be placed in a room and surrounded with dry ashes and loam, and it will be found that in a wonderfully short time the lead is attacked.

The various preservative compounds that are used give good results, but in time the writer thinks that all metal other than the actual copper conductors will have to be discarded.

ALUMINIUM MAINS IN PRACTICE.

[COMMUNICATED.]

It may prove interesting to state observations taken on an installation of aluminium wires, as mains of an overhead system of distribution, used in the small town of Northallerton, in Yorkshire. This station, owned by the Northallerton Electric Light and Power Company, Limited, was inaugurated in the autumn of 1899, and to keep the first cost as low as possible, aluminium was adopted for the main distributors. From the generating station two aluminium wires, ·75 in. in diameter, were erected overhead on both sides of the main street, which is very wide, the private consumers being directly coupled to these two mains, negative and positive respectively.

The public lighting of arc lamps was taken off the negative aluminium, and a positive switch wire of copper was taken back overhead to the station. When the arc lamps were switched out at a certain hour, incandescent lamps fixed on the same poles were switched on by another switch wire, one pole of the incandescent lamps being connected to the negative aluminium, and the other pole to a positive switch wire of copper, which was taken overhead to the station. These wires being stretched side by side, it was convenient to observe their relative actions under practical working conditions.

The steel posts for the suspension of these wires were placed at the maximum distance apart, namely, 200 ft. The aluminium spanned this distance very neatly, and in this respect was better than copper, but its appearance was very ugly, owing to its increased diameter. This span of 200 ft. seems quite safe, and no accident of wires falling has taken place. These wires have been subject to severe trials in gales and storms, and even when covered with snow they have suffered no injury. The wire used is the ordinary commercial aluminium metal supplied by the British Aluminium Company. The aluminium procured had a conductivity of 51 per cent., taking copper equal to 100, and its chemical composition being 98·1 per cent. aluminium, the remaining part of 1·9 per cent. being an impurity, the greater part being iron. By practice, however, it is found that a span of 150 ft. is the most suitable and reliable.

The jointing of the aluminium ends was done by an ordinary brass socket. A piece of yellow brass, 2 in. by 1·25 in. in diameter, was taken, and a hole bored right through it; this hole was tapped (Whitworth thread being used), the brass socket was then screwed on both ends of the aluminium. This joint has been very successful mechanically, and no failures have occurred in the joints made in this manner. The joint is subject to corrosion, but it is this corrosion which, peculiar to state, makes it so mechanically safe. Joints were cut out and tested mechanically, and in all cases the aluminium could not be screwed out of the brass socket, and to open the joint the socket had to be sawn through. These joints were then placed in a testing machine, and in all cases the wire itself broke before the joint gave way, the tensile strength being equal to 16 tons per square inch. On close examination of the joint, a dark white oxide was present, and this was distributed over all the surface, and not a clear metallic surface was visible. It appeared evident that the joints had firmly oxidised together, though to no detrimental degree mechanically, but a rise in resistance was noticed in these joints when they were measured. A series of electrical tests was then made upon two sets of these joints. One set of joints was taken as samples after they had been made for one week, and the other set after they had been up, in practical use, for 12 months. In all cases it was found that the resistance of the old joints had increased 350 to 580 per cent. that of the new joints. It seems evident that, after a space of time, these joints will become total non-conductors, due to a complete film of oxide separating the two metals. But this time period will depend upon the tightness or fit of the metals. A badly-made joint may only last a short time, but a well-made one may last for years. After 15 months' working at Northallerton there has been no trouble through the joints discontinuing to conduct.

Through the above aluminium conductors and joints a current exceeding 200 amperes is passed at times of heavy load, and several joints were under observation, but no trouble arose, nor did any perceptible heating take place. The surface of the aluminium showed signs of oxidation or corrosion. It seemed pitted and eaten away more in some places than others, and all over the surface showed a darkish white deposit of oxide. The air at Northallerton, in Yorkshire, is said to be fairly pure; but the air is only one consideration, for the corrosion on the wires greatly depends upon the condition of atmosphere. For instance, periodic sunshine and rain do more harm in assisting corrosion than a lengthy period of rain or sunshine; this is only natural, and is very marked in actual practice. Cases have come under observation where, during a rain storm, a good circuit was maintained through a joint, but after the rain ceased and the sun commenced to shine, the joint lost its conductivity, and finally was no good at all. The joint that was most affected by the above conditions was a copper and aluminium joint, and two aluminium joints were nearly as bad. The services of copper wire were taken off the main aluminiums, and led overhead to insulators placed on the consumer's house wall. The greatest trouble experienced was with these joints, the copper wire being wrapped and bound round the aluminium, then insulated and protected from the weather by rubber tape and insulating paint. This class of joint was found the most lasting and suitable, but it gave trouble. The sun and rain used to play havoc with the joint, till finally it gave way. The greater part of these joints that ceased to conduct, ceased instantly, and it was no common occurrence on a windy night to have the consumer's lights bobbing up and down through these defective joints. A number of these fagged-out joints were examined, and although they were found to be perfectly tight they ceased to conduct, and on the resistance being measured it was found to vary between 100,000 ohms and 2 megohms. Some of these copper wires that had been twisted round the aluminium were found to be strongly welded to it by the oxide, and by observation it looked to be a very good joint. The average life of this class of joint was about six months, and in no instance has a joint made between copper and aluminium been satisfactory. It remains to be seen whether a soldered joint will be as good mechanically and electrically as an ordinary made up joint. Soldering aluminium is simply melting it together, and it does not seem feasible that the melted joint will be as strong as a made up one; electrically it may be inferior. Soldered joints have never been tried at Northallerton, as the expense of trials would be too great, and most probably have led to inconvenience.

The copper mains have proved very satisfactory, and joints made by the hands, and left bare to atmospheric conditions, have given no trouble, and when measured electrically, under the same conditions as the aluminium, the increase of resistance was found to be only 5 per cent. The joints were found to be in a very good condition after being up under working conditions for over 12 months. With the copper mains, joints could be freely made by a man in a short space of time. With aluminium mains, to make a good joint took an experienced man twice as long, and then

it could not be relied upon to last any length of time. It has been proved by actual experience that to use aluminium mains for distribution, the cost of same, including maintenance for a given period, exceeds that of copper under the same conditions. It can be said that aluminium is cheaper than copper, but this only holds good for the first cost, or cost of material. To place aluminium wires overhead requires experience and care, and the time taken during the operations amounts to four times that of placing copper mains in position, that is when the conditions suitable for the erection of aluminium is at its very best. The maintenance, upkeep, &c., not mentioning the unreliability, &c., raises its total cost after one year to an amount equal to 10 per cent. of the total cost of a copper installation under the same conditions, and this has been proved by actual experience. The general information obtainable simply states that aluminium is cheaper than copper for this purpose, but it omits the cost of erection and maintenance, which seem the two most important factors of the cost and success of the system after a period of time. From experience gained it seems evident that aluminium will be left alone when copper can be obtained and used for overhead constructional work. In an aluminium installation its first cost is less than a similar one of copper, but after one year's work its cost then exceeds that of the copper installation. It is very evident from experience gained by actual practical work on commercial lines that aluminium wire as an overhead conductor is very unsatisfactory. Of course, if this experience had been known at first, copper would have taken the place of aluminium in the above-mentioned installation. Experience is a dear school, but it is the best.

THE AMERICAN STEEL TRUST.

The American system of mammoth trusts may be considered very ingenious, economic scheming, but so far experience has shown it to be advantageous to the select party of financiers or organisers, and detrimental to the people's best interests, being by no means conducive to a greater degree of industrial prosperity.

Most of us know what it means if the world's supplies of any line of generally consumed products—whether food stuffs or industrial goods—come under the control of a group of oligarchical multi-millionaire financiers of American cuteness. Sometimes the general body of industrial workers is severely handled by works being closed down owing to the price of raw materials, and legitimate industry receives a check purely for the gratification of a few financiers already fabulously rich. The operations of the worker are thrown out of gear. The system is iniquitous, and it is not surprising that the attitude of the American people toward it should be one approaching to open revolt.

But we are not laying ourselves out at the moment for a detailed tirade against these combinations. We can only express grave apprehensions as to their results, both direct and indirect, upon the industrial conditions of the world.

We made some observations the week before last upon the position of England's steel trade, and ear-marked its decline. Quite certain does it now appear in the presence of the vast American Steel Trust with its £230,000,000, that British steel manufacturers will have to rise in all their strength to struggle with this elephantine competitor, if they are to retain anything like a reasonable share of the world's steel business.

There is a rumour of the outside steel works in the States, who will undoubtedly be hit by this combine, joining hands in a counter-combination to fight their rival. This must mean a deadly struggle within the States, dangerous undercutting of prices, a mightier conflict than ever in competing for foreign business—all of which might be interesting enough to watch from the outside were it not for its certain effect upon our home, Colonial and foreign markets. Where will the British manufacturer stand—we had almost said fall? But supposing there is no counter-combination? This Trust, it is said, will control two-thirds of the world's steel supplies, and its flotation was professedly devised with the two-fold object of strengthening America's position in foreign trade and effecting economies in the cost of production and manufacture. There was, of course, one prime consideration, and these two are subsidiary motives. It is suggested in some quarters that the capital of some of the companies now swallowed up was already excessive, and now that the great deal has taken place, the total capitalisation is still further added to to an enormous extent. This of necessity means there must be either a greatly increased profit or marked economy in working if a fair profit is to be paid on the 230 millions. Perhaps there will be both! With lower selling prices the British manufacturer would find competition the keener, but if prices are worked up, the fair profit can be easily earned; while with American prices higher it may reasonably be supposed that English firms should also be better able to compete. But there, it is impossible to imagine what this mammoth Trust may or may not lead to.

If this sort of thing were carried far, and were shown to be seriously affecting us, we dare hope that the British nation would allow its good sense to prevail, and lean toward the side of fair instead of free trade, at home and in the Colonies; yet if the British steel manufacturer lays himself open to a charge of apathetic regard for his own interests, he is not helping matters in that direction. We shall probably be favoured in due course with the views of certain English steel firms as to the probable effect of American movements. Doubtless, some enterprising technical journal, more closely identified with the industry than we ourselves, is already engaged upon the idea. Certainly, their views will be interesting, but we are afraid to let anticipations take possession of us lest we find our steel makers not in the least ruffled, and expressing happy sentiments that "We can assure you there is absolutely not the least ground for the slightest alarm." As a matter of fact, this actually proves to be the attitude adopted by certain Sheffield manufacturers. Happily, Scotch firms are not so supinely optimistic, and they are, according to reports, fully acquainted with the actual seriousness of the situation.

If the American Trust principle could be applied to British steel industry in such a manner as to better prepare it for competition, by erecting new works on up-to-date principles, scrapping out-of-date and uneconomical machinery and methods, and generally fitting it to meet the demand both in quantity and character of product, we should feel inclined to give it our blessing. But this we do not think it capable of doing. Yet we are tempted to ask whether the present is not an opportune moment to establish some new English organisation with a view to setting British steel manufacturing on to a better footing.

THE ELECTRICAL POWER BILLS OF 1900.

In our last issue we described Mr. Madgen's Institution paper as composed of some reflections and a moral. The reflections were multiplied and the moral driven home by the many speakers in the discussion. An M.P. (Mr. Vesey Knox), Mr. R. P. Sellon, Mr. J. S. Raworth, Mr. A. C. Swinton, Mr. Sidney Morse, Mr. Garcke, and Mr. Crompton, and another M.P. (Mr. Atherley Jones) strongly supported Mr. Madgen's position; Mr. Hammond objected to his views, and was practically backed up by Prof. Ayrton, while Mr. Addenbrooke and Prof. S. P. Thompson considered the technical points which arose out of the paper. Mr. Clay, General Webber, and Mr. Gavey introduced the question of telephonic progress, the first mentioned naturally being in opposition to the other two speakers.

The paper was held to deal with matters which are issues of life or death to the industry of electrical engineering in England. It had to be asked, Are we behind the position we ought to occupy, and what are the causes? Is it to the interest of the public that there should be a small number of large stations, or many small ones? The spirit of the times is the consolidation of industries. English engineers should go out and solve these questions, and be given the opportunity of doing what is being done in other countries. The explanation put forward by most of the speakers was that the industry had suffered from being dealt

with not on its intrinsic merits but on political considerations. Its birth and growth happened to be coincident with the progress of the municipal idea, and it had been made the plaything of politicians. As a result, investors had grown to look askance at electrical enterprise. Before progress could be made, the present disabilities must be removed. Capital even now is obtained with great difficulty.

Take the gas companies of the United Kingdom and Ireland; the total revenue was £1,606,000 per annum for the electricity concerns, but the mere increase in revenue between 1896 and 1898 of the gas companies exceeded the sum total of all the electricity businesses. That should have gone into the pockets of electrical engineers. Against 198 electricity works there were 661 gas companies. If arguments had been adduced a short time ago as to why this was, some people would have suggested the real reason as the speculation in electrical business in 1882, but investors have not such a long memory, and more was primarily due to the Tramway and Electric Lighting Acts, and the way these had been administered by the Board of Trade; a Board which, as an authority has stated, exists merely in name, and is seldom called together, although at one time there were merchants of the City of London sitting on it, and it was thought it would be a very good thing if this were done again. The new industry being in the hands of municipalities who could not speculate, things proceeded very slowly. At the beginning of new enterprises, there must be a speculative period, and therefore the only legitimate way of trying any new thing was by private enterprise. It was not the inefficiency of English engineers that kept English electrical engineering behind the United States and the Continent, but external causes. Other countries have done next to nothing that we at home did not do first, and electrical engineers are the salt of the mechanical engineering profession in this country.

As it is no use discussing the dielectric losses in cables if there are no cables to have losses in, everyone agreed that the cause should be sought. The general opinion seemed to be that while municipal government should in every way be encouraged, the Legislature had perhaps coddled municipal authorities too much. There was no objection to municipal trading, but as municipalities did not manage a business as well as a company, they would not choose to come into the field where there was free trade. What was wanted was fair play and free play. The present position of the electric lighting industry was attributable to unreasonable difficulties put in its way by local authorities, backwardness being due to municipal restrictions. Municipalities competed with private enterprise by means of the rates, and profits of trade were transferred from companies to local authorities. The benefit of the public should not be over-ridden by municipalities, and the veto at present held by them must be removed. One method suggested was to merge the unit of local Government into the counties and thereby extend a principle already adopted in other matters. The whole question narrowed itself down to one of price, and power schemes offered a cheap supply of energy, which local authorities could distribute. Small stations spent a sum on mains quite out of proportion to the number of consumers. Cork was cited as an example of what a cheap rate would do. There the charges of 5d. and 1d. (as mentioned a few weeks ago in our summary of accounts) had produced remarkable results.

The foregoing condenses the arguments of the attacking party. These were met by the opinion that cheap gas in this country had to be met in competition, and in places like Switzerland gas cannot be got at any price, while in New York a few years ago gas cost 10s. per 1,000 cubic feet. Also that a debt of gratitude was due to local authorities, who had invested £14,000,000 out of £25,000,000, and had produced and sold electrical energy at a cheap rate.

Prices obtained.	Number of companies.	Number of local authorities.
Below 3d.	—	2
3d. to 3½d.	—	6
3½d. to 4d.	3	9
4d. to 4½d.	5	25
Below 5d.	5	18

On the Continent nearly all the towns proposed to be visited in Germany by members joining in the Institution trip this summer have municipal works.

The technical questions suggested for consideration included, Where are the large stations worked by coal not only transmitting but distributing? What is the proper basis for reckoning out the proper size of unit for power? Is it true that when you get up to 10,000 H.P. it does not pay to increase to 20,000 H.P. in one station? What is the distance at which cost of distribution counter-balances economy due to concentration of plant? What is the limit of kilowatts in a station beyond which the resulting economy does not pay? What are the means going to be adopted to preserve uniformity of pressure within efficient limits? To these questions answers remain to be given.

CORRESPONDENCE.

The "Accuracy Factor" in Power Distribution.

Although the Institution audience spent two whole evenings hearing how the veto of local authorities barred the way to the development of power-distribution in this country, it appears that many of those present are still quite in the dark as to the real character of this so-called veto.

And yet the Parliamentary Committee that devoted nine weeks to taking evidence had for its chairman Sir James Kitson, who is not merely an M.P., but is the head of a great manufacturing firm, the director of a great railway, and the ex-mayor of a great city, and on June 27th of last year, gave this most equitable decision:—

"A local authority which undertakes and is prepared to give a full and ample supply of electrical energy for all purposes to consumers within its district, ought not, without its consent, to be required to give facilities for the supply, within its district, of electrical energy by other undertakers. But if a local authority is unable or unwilling to provide on reasonable terms and within a reasonable time a full and adequate supply of electrical energy for any purpose to any company or person applying for the same within its district, such company or person should be at liberty, after notice to the local authority, to obtain their supply from other authorised undertakers, and the local authority should be required to give all necessary facilities for this purpose."

Now is it accurate, or even diplomatic, to call this decision one of "the obstacles set in the path of our industry by the governing bodies of this country," and is it not rather a decision which puts local authorities on their mettle?

For what the Committee decided comes to practically this: if you, local authorities, realise what are your duties in providing for all your people "on reasonable terms, and within a reasonable time, a full and adequate supply of electrical energy for any purpose," we will be no parties to any hindrance being put in your way. But if your district be one in which bumbledom reigns supreme, then our declaration is that no municipal barrier shall be left standing to oppose the free entrance of those who come with offers of cheap electric energy.

W. E. Ayrton.

Note.—The "accuracy factor" may be defined as the ratio of truly what it is to apparently what it is.

Depreciation.

The leading article in last week's Review draws timely attention to a most important question which has undoubtedly been hitherto insufficiently considered by a great majority of the local authorities which have undertaken to supply electrical energy.

These bodies will owe you a deep debt of gratitude if the result of your somewhat violent attack on them (was it suggested by Mr. Madgen's paper?) is to settle the principle which should guide them in determining the amount to be set aside out of revenue to cover depreciation.

In the hope of directing discussion to this practical end, I venture to suggest the following:—"It is the duty of a local authority to provide, out of revenue, a fund sufficient to maintain their plant in efficient working order for the same period of time as the sinking fund for repayment of

loans is calculated to run, but it need not provide for more."

Strict justice to both the present ratepayer and to the ratepayer of, say, 30 years hence, requires that when the automatic action of the sinking fund shall have wiped off the original debt, at that date the automatic action of "wear and tear" shall have reduced the value of the plant to practically nothing.

It is for engineers to determine in each case the average "life" of different parts of the plant, and given these data the actuary can calculate the yearly amount required to provide for renewals.

If the basis suggested is correct, no allowance need be made on account of depreciation of land or substantial buildings. Land in the close vicinity of towns usually appreciates in value, and no one will contend that a substantially-constructed building will, if kept in proper repair (such repairs being, as usual, charged against revenue) require to be pulled down and rebuilt at the end of 30 or 35 years. Strictly speaking, therefore, the present ratepayer is, in providing the sinking fund, already bearing more than his just share of the first cost of land and buildings.

Electric lighting machinery is, in a well-designed station, run under particularly favourable conditions. It is not subject to violent shocks or to overloads, and it is nearly always kept in perfect order. Under these conditions the life of, say, a Willans engine will not be less than 15 years, and some of the larger slow-speed engines now being erected may confidently be expected to last even longer.

The life of accumulators is more difficult to estimate. So much depends, in this case, on the personal factor. I know of stations where a ten-years' life may be counted on, and of others where five years would be too long an allowance.

To illustrate the general effect of the above suggestions, I will take the case of a new station and will assume that 2½ per cent. on the capital cost is to be yearly set aside as a sinking fund to accumulate at 2½ per cent. compound interest. This sinking fund would provide for the repayment of the capital in 30 years.

No depreciation would be required on land and buildings: on machinery at 15 years' life a sum equal to 3·6 per cent. on first cost set aside for 30 years at 2½ per cent. compound interest will provide for the repayment of a loan equal to the original cost, such loan to be obtained 15 years hence, and repaid with 3 per cent. compound interest 30 years hence. For those parts of the plant that have a life of 20 years 2·7 per cent. should be similarly set aside to repay the cost of renewal at the end of 40 years, *i.e.*, at the end of the life of the second set. The amount should, strictly speaking, be less, as during the last ten years of the life of this part of the plant no interest or sinking fund charges would be payable.

It would seem, therefore, that a charge of 3 per cent. on first cost, exclusive of lands and buildings, should meet all the requirements for renewals as distinct from "repairs and maintenance" where the rates of interest are as here assumed.

The question of the "life" of the different parts of a supply station plant is a difficult one, and there are, as far as I am aware, but few data available from actual experience as yet, since most of the 10 and 15-year old stations have scrapped or sold their original plant, not so much because it was worn out as because it paid to do so when more economical plant could be obtained or larger units could be run.

David Urquhart.

A New Slotted Conduit.

In connection with your remarks on "A New Slotted Conduit" in your issue of last week, it appears to me that your last paragraph:—"On the whole, we cannot hold out to the inventor any prospects of his design being adopted in practice despite its ingenuity," is rather sweeping, and hardly justified by your criticisms on the design. Taking the points raised by you in detail. The use of Z bars to form the sides and top of the conduit does away with the usual practice of forming the conduit in concrete between the yokes, obtaining a more mechanical construction and one which is very easy to lay. The Z bars will no doubt be made sufficiently strong to ensure a minimum risk of the slot closing due to the overhang, and the method shown of securing the lower flanges to girders spaced at short intervals, and also tying the sides to the track rails, appears to be amply sufficient to prevent any tilting of the section, especially as the whole construction is bedded in solid concrete. The iron frames which carry the access doors could be bolted down by foundation bolts passing through their lower flanges, as well as being supported by the ends of the Z bars, and the strength of the access doors should only be a question of sufficient metal. The cast iron sleepers are evidently intended to tie the whole construction together, and their lack of width would obviate the necessity of a concrete bed to rest on.

The insulators are not likely to work out sideways if they fit properly, and in any case, should such a thing happen, the conductor need not drop on to the iron jaw of the holder, as the description claims that the insulators can be removed for cleaning and renewal without disturbing the continuity of the conductors. In answer to the question, "How would the insulators fit on a curve?" in most curves the length on the curve taken up by the bearing portion of the insulator, which appears to be about 4 in., will approximate very nearly to a straight line, so the ordinary insulators could be used, and in extreme cases specially curved insulators would be necessary.

The invention has certainly attained its primary object—namely, a shallow conduit at moderate cost—and, as such, should commend itself to the municipal authorities and others who at the present time are contemplating the adoption of some form of conduit system, and who are unwilling to spend large sums in alterations to existing water and gas mains in order to make room for a deep conduit.

A. B. Rigby.

Chiswick, *March 4th*, 1901.

With reference to the review of my conduit system in your issue of last week, I shall be obliged if you will allow me space in which to answer your queries, and also to explain the points to which you take exception.

In the first place you appear to have attached undue importance to the details shown on drawings, which were principally intended to give a general idea of the main points of the system; and I do not see that your criticisms justify the concluding remark that you cannot hold out any prospect of the system being adopted.

You say the combination of the slot-rails with the walls of the conduit calls for a very great weight of iron in the construction—this is, to some extent, true, although you have over-estimated the amount; however, I fail to see wherein the objection lies, inasmuch as the cost per mile of track completed, compares very favourably with other systems, moreover, this combination facilitates rapid construction to a very great extent.

With reference to your remark concerning the support given to the Z-rails, I would point out that this is not only effected by the sleepers and tie bars, but also by the iron frames which carry the access doors and the concrete.

The access door frames are not shown in detail on the drawings, but these are fixed to the concrete bed by long bolts, and are specially designed to support the ends of the Z-rails; the Z-rails thus supported at the ends have been made of sufficient strength to resist any closure of the slot through deflection due to the heaviest possible traffic.

It is also obvious that the access doors can be designed to withstand any probable load.

With regard to the extra concrete under the sleepers, I do not think this would be necessary, as the side flanges afford sufficient hold on the concrete bed, and I can, therefore, see no reason for increasing the excavation.

It is not claimed that the number of insulators is reduced, but that there is a marked decrease in the number of access doors necessary, these being preferably placed at intervals of about 24 ft., in which case the insulators would average 12 ft. pitch.

The design of the insulators must surely guarantee unusual strength, inasmuch as the conductors are directly supported

in the insulators by the holders, instead of by long arms as in other systems, and further protection is afforded by the spring packing.

There is no tendency for the insulators to slip out sideways, as the holders and conductors are stationary, moreover, the weight of the conductors and the pressure of the spring packing would entirely prevent such an accident.

It would not be necessary to alter the insulators for curves of large radii, but for those of 40 ft. radius specially curved insulators have been allowed for.

Frank Hewer, A.M.I.E.E.

Chiswick, *March 4th*, 1901.

[Our correspondents will surely concede that any criticism we could make must be founded on the drawings before us, the whole of which we published in our last issue. Various modifications of the plans are suggested in their letters, which would materially alter the conditions—notably those of utilising the door frames as *supports* for the Z-rails, and spacing them 24 ft. instead of 18 ft. apart; but we have little faith in the rigidity ascribed to the concrete bed. As for the strength of the insulators and their tendency to work out, we are still unconvinced.—Eds. Elec. Rev.]

Standardisation of Commutator Bars.

Referring to the letter appearing in your last issue *re* "Standardisation of Commutator Bars," there are some statements contained therein with reference to mica which we cannot allow to pass unchallenged.

Your correspondents state that they have "gone over tons and tons of mica to endeavour possibly to supply a few hundred segments of a certain size, where, had the manufacturer employed a size of mica $\frac{1}{4}$ in. shorter, he would have purchased his insulation at a quarter the price he paid for it." To show the ridiculous nature of this statement, we will give the following typical instance. A dynamo manufacturer requires mica segments 15 in. long, for which he pays 14s. per lb.; according to your correspondents, if he took these segments $14\frac{3}{4}$ in. long, he would only pay 3s. 6d. per lb. The manufacturer knows, as a matter of fact, that he would only have to pay a few pence less for the shorter length of mica.

We are surprised that a firm who claim to have "unique experience" in the supply of mica and micanite, should publish such statements as the one we quote.

As we have no desire to obtain a gratuitous advertisement, we enclose our card, and sign ourselves,

A Firm of Mica Merchants.

March 5th, 1901.

What is a Wireman?

Will any reader be good enough to define the terms "Wireman" and "Electrician," as I find that any man who can drive a nail or fit up an ordinary bell and battery at once adopts one of those titles, and undertakes electric light wiring for the lowest wage he can exist upon, and after a few months' experience he becomes a member of the local branch of the Electrical Trades Union, which exists in nearly all the large towns, for the purpose of obtaining the "standard" rate of wages, and if they were sorted out 50 per cent. of the members would be found to be that class of workman, who would not be allowed to enter the ranks of any other trades society; in fact, at the present time this existing union is nothing less than a refuge for wasters cast off from other trades.

It is not surprising, then, that members of other societies will not recognise them in any way, whether on the works or not.

Such has been my experience on a large installation, where the other contractors' men absolutely ignored the existence of wiremen on the job. The result was men would not stop on the works, and constant changes were made.

Through that treatment I have severed my connection with house and ship wiring, and I have been successful in obtaining a post on the staff of a large generating station, where respect is shown to a skilled man by his fellow workers of every grade.

I have seen wiring that would turn any consulting engineer's hair grey, covered in with the remark that "Anything will do so long as the lamps burn." If wiring is to be done in a proper manner, good men must be employed to do it, and if the union will not weed out the undesirables, the struggle must go on until it eventually ends in the survival of the fittest.

If every workman were registered and required to pass a qualifying examination, as plumbers who desire to be sanitary engineers do, the title electrician would be worth obtaining, and would not be, as at the present, available to anyone who chooses to call himself such.

Jointer.

Birmingham, *March 4th*, 1901.

INSTITUTION OF ELECTRICAL ENGINEERS (MANCHESTER SECTION).

ON THE USE OF STORAGE BATTERIES IN CONNECTION WITH ELECTRIC TRAMWAYS.

By G. A. Grindle, M.I.E.E.

(*Abstract of Paper read February 26th*, 1901.)

For upwards of 10 years no practical result of the storage battery mark the pages of the early history of electric traction, and up to the present time (in Great Britain at any rate) no practical demonstration has taken place that can be deemed an unqualified success.

It is not my intention in the present paper to discuss this particular problem of the application of storage batteries to electric traction, and I purpose only making a passing reference to it.

The problem is an extremely intricate one, and one which, I regret to say, I feel absolutely convinced has never had the attention paid to it that its importance merits.

The most serious attempt made in Great Britain so far has been that made at Birmingham commencing in the year 1890, but here the result has been, owing entirely to the nature of the equipment, and the capacity of the line, anything but a success. Up to 1894 the losses on the line were attributed to the cost of up-keep of the batteries. At that date, however, with the view of ascertaining the true facts of the case, the supply of batteries was undertaken on a definite figure per mile. Since that date, unfortunately and significantly, no data of running costs have been forthcoming, but batteries have been supplied and car miles run to the extent of over 1,100,000 miles, and, from the accumulator view of cost, with highly satisfactory results. With accurately kept figures on an aggregate mileage of this amount, something more than theoretical calculations can be obtained, and the result is such as to firmly convince me that, in spite of its failures hitherto, there is a very great future before this method of traction. Its adoption at the present moment in New York on Thirty-fourth Street is attracting considerable attention. The closest attention is there being paid to details, and in view of the extended experience available as to mechanical equipment and its problems, the system will most probably at last have an effective opportunity of demonstrating its capabilities. As with the trolley system, America promises to demonstrate to this country the value of the storage system, and how to operate it.

In 1894 two tramway systems came into operation, on both of which batteries were adopted, one being the Douglas and Laxey tramway, in the Isle of Man, for the design and equipment of which your chairman was responsible; the other case the Zurich electric tramways.

As to on which system it was first contemplated to employ accumulators it is impossible to say, or whether the designer of either scheme was aware what the other was doing or contemplating. It is possible that the same idea of employing batteries was arrived at in both schemes entirely independently; at any rate, the object and method of employing them was entirely different.

In the first instance the battery was employed at an outlying sub-station, situated somewhere about midway between the terminal points of the line. The battery in this instance was operated by means of a special feeder from the generating station at Douglas, the charging being effected by means of an ordinary motor-generator installed in the battery house. The function of the battery was to assist the line load, which at the point of the line where the battery was installed was of an exceptionally heavy nature at times, generally to assist in maintaining the line potential at or about the centre of the system, and to obviate the necessity of sending the maximum amount of current demanded over the long feeders from the power house. Variations of the battery potential were compensated for by a portion of the battery being employed as regulating cells, the regulation being effected by hand.

In the second instance the battery was installed at the power station, the principal function of the battery being to equalise the load on the generators, allowing a much smaller power plant to effect the operation of the line. The battery in this case was charged by means of an auxiliary generator in conjunction with the main generator, and the regulation effected by means of regulating cells cut in or out as necessary by means of an automatic switching arrangement.

These two first instances of the adoption of batteries in traction working, though neither of them can, when compared with recent practice, be considered as ideal methods of employment, nevertheless are distinctly interesting in view of subsequent development, and have gone far to demonstrate the necessity for a storage battery. One has only to take a glance at the load curve of any traction system to see the necessity and call for the employment of a storage battery. The usual load curve reminds one of nothing so much as an attenuated mountain range, with one moment lofty peaks ranging skywards, and the next moment low-lying passes down at times to "sea-level." [The author showed load curves illustrating this, and stated that though the wide ranges may tend to decrease in number on large systems, the liability to their occurrence still exists and has to be provided for.] Nothing more detrimental to a generating plant can well be imagined, the violent stresses between full and no load occurring so suddenly and often consecutively following on each other. The necessity also arises when it is desirable to maintain the voltage as nearly as possible constant. No matter to how fine a point the governing of the engine is carried, it is impossible for it to respond with anything like the rapidity with which the variations in the load take place. The most perfect mechanical governor has a distinct time factor as compared with that of switching on a motor, nor can even a generator itself respond so quickly, with the result that the voltage of the line rises and falls.

A battery is further a distinct necessity where it is desirable to centralise as much as possible the operating plant, as is nearly always the case, and often save an additional station with its attendant staff.

A battery is an absolute necessity where the available power is limited to little more than the mean day load, as is often the case where water-power is employed, and in many instances small falls of water which by themselves would be quite inadequate to successfully operate a small line, with the assistance of a battery can do so easily.

Admitting, therefore, the necessity for a battery, we will next consider the advantages to be obtained by the inclusion of a battery on a power system.

The first and undoubtedly foremost advantage to be gained by a reliable battery, properly installed and duly proportioned for the work it has to effect, is the simplification of the question of generation of energy, resolving this from being one of a constantly varying nature, varying from nothing to several times its mean, to the one simple question of generating an even, steady, and predetermined load. By enabling the prime motor to be run constantly at an even load, it naturally follows that this load can be arranged to be the most economical one for the motor employed, which will result in an enormous economy over what could be obtained by employing a prime motor, which would of necessity have to be at least three times its size in order to enable it to cope with the maximum demand which may from time to time be thrown upon it. In fact, it is almost impossible to conceive an engine being run under more disadvantageous conditions than those which obtained in the production of energy for an average railway system where no battery is employed. This advantage is best evidenced by the coal bill. The lbs. of coal per H.P.-hour on electric traction systems is, I think it will generally be admitted, beyond all reason, in many instances ranging up to 10 lbs., and even more, by the employment of a storage battery. There is not the slightest reason why this should not be reduced down to the best engine practice, namely, from 2 to 2½ lbs.

An advantage, and an important one from a point of cost, is the reduction of the engine room hours. In this country few, if any, tramways run the full 24 hours, but where they do (and it is as well to bear in mind that there is a growing tendency towards its adoption), what may be termed the "night-load" is of the smallest nature; this load can be taken entirely by the battery.

Apart from the question of where a 24-hour system is in force and where the current English practice has only to be provided for, the employment of a storage battery enables a considerable reduction of hours to be made in the daily work, and will in most instances easily bring the running of the station within the limits of two shifts, leaving the early and the late cars to be both operated entirely off the battery. In an average station this should mean at least a saving of from £150 to £200 per annum.

It is a distinct advantage in the saving of wear and tear of machinery, not only in the power plant, but also the cars, the sudden and violent variations of voltage, which must of necessity continuously occur where no battery is used, throw a large amount of unnecessary strain on the running motors, which is much modified, if not entirely eliminated, when a battery is employed. A distinct advantage is shown in the running of the cars; better time can be kept and more even running. The car lighting will be steadier and the destruction of lamps decreased. An important advantage is the safeguard it effects against accidents, more particularly fly-wheel accidents and breaking of belts in cases where the latter are employed, as in the event of a "short" or sudden overload on the line the extra demand of current will be immediately taken by the battery and not by the generator. Should the "short" be sufficiently great to throw out the circuit-breaker there will still be no variation on the generator load, the battery absorbing it all. While when the circuit-breaker is closed again, even though the cause of throwing it out may have been removed, there is almost certain to be an abnormal demand on the line for current, due to the almost simultaneous restarting of the cars. All this will be immediately taken by the battery without any abnormal load whatever being thrown upon the engine. In fact, the investment in a battery may be looked upon as a very excellent form of machinery insurance.

In cases where belts are used for driving, experience has shown that where a battery is not employed a severe shock will almost invariably break the belt before releasing the cut-out. While where a battery is in operation the circuit breaker will invariably operate first, saving the belt.

Another advantage, and one of considerable importance, is that the battery will often carry through, where without one a stoppage would be absolutely inevitable. I do not say that every accident which has caused the stoppage of an electric line might have been prevented by the employment of a battery; but a vast number of stoppages which have occurred, have been due in many instances to mere trifles, and would never have taken place. The advantage of being able at any time to shut down an engine for a few minutes, I venture to think, will be universally acknowledged.

A very strong factor amongst the advantages of employing batteries on traction systems is the facilities they afford when, as is often the case, extensions or increased car service become imperative. By the installation of batteries at the extremities of existing lines extensions become feasible without any interference whatever with the existing arrangements and consequent expense, in many cases saving the necessity for additional power sub-stations, which, unless the extensions are very great, must work under most disadvantageous conditions.

Having admitted the necessity and the advantage of employing a battery, there yet remains one great factor to be consulted, and one which in the present day there is a very lamentable tendency to unduly exalt, and at the shrine of which many a good scheme and many a good job have been unfortunately sacrified, it is the question of cost.

There are two things that require to be very carefully avoided, first, schemes that cannot possibly pay if properly carried out; second, lavish expenditure that cannot be recouped.

Eliminating these from our consideration, and provided that no cheese-paring policy is adopted of endeavouring to make one pound's worth do the work of two, or in other words, it being ensured that an adequate battery will be properly installed and equipped, as to whether or no the necessary outlay which must be incurred to include such a battery on a traction system is justified there are no two questions, as there is not the slightest doubt whatever that it is the means of a material saving, both in the prime outlay on operating plant and the subsequent cost of operation of same.

(To be continued.)

LEGAL.

ELECTRICAL AND GENERAL ENGINEERING COMPANY *v.* AITKENS.

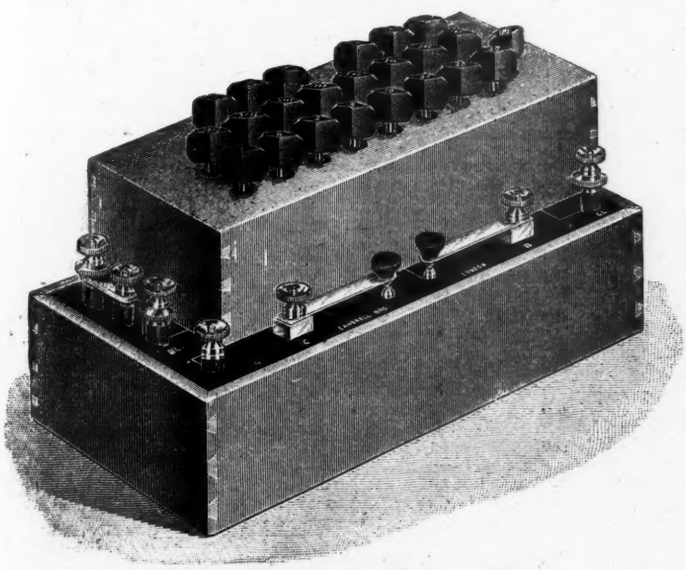
In the City of London Court, on Friday, before the Deputy Judge and a jury, this action was disposed of, it having been remitted from the High Court. The claim was made by the plaintiffs, of 17, Gracechurch Street, E.C., to recover the sum of £111 from Mr. Albert J. Aitkens, Fernwood, Camden Wood, Chislehurst, for work done in installing the electric light at his house.

Mr. TURNER, counsel for the plaintiffs, said that the defendant had paid £95 of the sum claimed, but now that the action had come into Court the defendant not only refused to pay the balance, but had set up a counterclaim in which he asked to be awarded £100 for defective workmanship on the part of the plaintiffs. The order was given and a specification supplied in September, 1899. The plaintiffs suggested that the wires should be carried in enamelled steel tubes, as by using them there would be greater protection from injury. An increase of 25 per cent. in the price was made for that. By a clerical error plaintiffs had only charged 20 per cent. in addition. It was arranged that the defendant should go to the offices of the General Electric Company in Cannon Street, and select the fittings which he would require, and that he was to receive a discount of 25 per cent. off the gross prices charged. The work was commenced in October, but it was not completed until early in January because of building alterations which were going on in the defendant's house. At last the electric light was duly installed, and when it was finished the plaintiffs in March sent in their account. Defendant commenced to make excuses why he should not pay their bill. He complained that there was a leakage of the current, but that was due to the dampness of the house. The main was put into the cellar, which was very damp indeed; in fact, the house reeked with dampness during the whole of the time that the plaintiffs were fitting up the light. The condition of the switches alone showed that there was a leakage of current through the dampness. The defendant complained that he could not turn out the light in the hall, and that it had to burn night and day. Afterwards he complained that he could not get the hall light to burn, and that the billiard room was in darkness The plaintiffs' men went down, and they found a considerable quantity of surface leakage, but it was all caused by the dampness. They found that the tubes had been damaged by the defendant's builders, and in the vestibule they took out a wire which had been injured while some floors were being put down. Fresh pipes were put in, and the work was left in a thoroughly complete state. There was no cause for the defendant's complaint.

Mr. J. A. BOWER (of the plaintiffs) stated that all the work sued for had been carried out under his personal supervision. He was not at Chislehurst the whole time that the work was being done, because he had to go into the country on other business. The contract required that they should instal the light to the approval of

the Electric Lighting Supply Company at Chislehurst, as well as of the fire insurance company. Both of those bodies had approved of the work, and the light was supplied after the approval so given. In cross-examination, he did not know that the electric current had been escaping all over the defendant's house. He was surprised that the defendant could not use the water in the lavatory because of the electric shock received upon putting the hands into the water. If there was such a shock it would not be dangerous. The defendant told them about it, and they immediately sent to rectify it. Directly the taps in the lavatory were touched electric current was conveyed to the hands. It was not true that the work was done inefficiently or in an unworkmanlike manner. They had not infringed the rules of the supply company by leaving down wires which were uncovered. If the supply company said the installation was at the present time dangerous to their own mains, as well as to the lives of the people in the house, it would not be true. The house had been sweating in a marvellous manner, and when he was down there on Monday last the place absolutely tasted of dampness, and the walls were wet. The work had been carried out in accordance with the supply company's rules, but the dampness permitted the current to leak notwithstanding. They had put in the best material. They did not use brazed joints. That was different work altogether. They had used open joints. The damp could not be excluded from the tubes containing the wires, because it was necessary to leave open spaces. He did not know that they had neglected to put any insulation between the main switchboard and the wall. When he entered into the contract he had no idea the place was so wet. On the previous Monday when he tested the electric light he found it quite satisfactory. The house had had a chance to dry lately, and the lights were all satisfactory except that the basement was wet. His firm consisted of three persons, himself, Mr. Joseph Bower, and Mr. Louis Schram. He was an A.I.E.E., and had had 10 years' experience. They could have supplied moisture-proof tubing instead of the enamel steel tubing, but the difference in price would have increased the expenses by 50 per cent. The dampness would condense everywhere. If the Fire Insurance Companies had anything to complain of in the defendant's house it would only have been fair to have given them a chance of remedying any defects if they existed. Dampness was a splendid conductor of electricity. The tubing which he used was of the best kind and of the sort which was generally found in houses. There was a better class of tubing used, but not usually. There were no joints in the better tubing, unless one had a lined tubing, which would cost three times more. The defendant could have had insulated steel tubing, but that was a fad more than anything else. He had never used brazed steel tubing, and if he had done so it would have made no difference.

Mr. L. Schram was also called to speak to the work being carried out properly. The cause of the leakage was excessive wet and moisture. The test which he made quite recently was satisfactory. There was no ground for suggesting that naked wires were put under the drawing-room floor. The electric light had been in use for 18 months now. The reason he did not use tubing with sealed-up joints to exclude the moisture was because it was not specified for. He did not know that the rubber round the wires had in some instances burned away in consequence of the electric current escaping. They did not take any exceptional precautions to provide against dampness.



Gambrell's Enclosed Plug Resistance Box.

Mr. Frederick J. Bower was also called, and he said he had had 10 years' experience as an electrician. The work was carried out under his supervision, and wherever it was unsatisfactory it was on account of dampness. The wire which was used was insulated with vulcanised rubber.

Mr. Henry C. Hall, A.I.E.E., arbitrator to the London Chamber of Arbitration, said he acted for the City of London Electric Lighting Company, and other large concerns, as an expert. He had spent five years in the manufacture of rubber, and he was of opinion that the rubber covering the wire used by the plaintiffs in the defendant's house was of the highest class used for house purposes. It was pure rubber. There was no remedy for the leakage which had been complained of. It was impossible to prevent it. If the plaintiffs had contracted to fix up an impossibility, that was no affair of his. The only way to get rid of the condensation was to dry the place, and then it would disappear. The best material was used in fitting up the electric light at the defendant's house.

For the defence, Mr. Colam said the complaint which the defendant made was a very serious one indeed. The inconvenience to which he had been put was also very great. The defendant had had to pay for a vast amount of electric current which had been wasted in consequence of the very defective way in which the plaintiffs had installed the light into his house. No one would ever be able to tell the extent of the defendant's loss, because the electric current had been escaping all over the house. The defendant had never had given to him the supply that the plaintiffs had contracted to put in. At the present time the defendant had only a partial supply. The Supply Company would not run the risk of allowing the defendant to leave on the current during the night, and he was compelled to shut it off during the greater part of the day. It was only in the evening that the defendant was allowed to use the light at all, and then only for limited hours. Furthermore, the defendant was still uninsured, because of the possibilities of fire, because the installation of electric light had been carried out so badly that the fire insurance company thought the risk too great to accept. The defendant now counterclaimed for damages for the plaintiffs' bad workmanship, and he asked the Court to give him something to cover his risk of non-insurance. It was very likely that difficulties would still arise, and all in consequence of the careless way in which the plaintiffs had done their work.

The jury here intimated that they only wanted evidence about the plaintiff having failed to comply with the supply company's requirements and the fire insurance company's stipulations.

Mr. Fricker, of the firm of Fricker, Miller & Co., 149, Fleet Street, E.C., said he was an M.I.E.E., and adviser to the London, Liverpool and Globe Insurance Company. He was requested by the insurance company to inspect the defendant's premises on January 30th with a view to insuring them against fire. Their rules had not been complied with, and he could not advise the company to accept the risk. Directly the main switch was on there was a dead earth. That was very serious, and it might be dangerous to fire and life. In his view it was not all due to dampness as suggested, but because of the imperfect material which the plaintiffs had used. Open joints had been laid in plaster work, and that was an improper thing to do. He did not notice that the house was particularly damp as had been alleged, and, in fact, the cellar seemed rather dry. The insulation had not been properly fixed, and the work was by no means high class. The wire was not the best that could be furnished. Wire enclosed in damp plaster ought to be put in hermetically sealed conduits.

Mr. F. S. Hanning, of the Electrical Supply Company, said he inspected the work in question. They had supplied the electric current to the defendant's house, but their requirements had not been complied with by the plaintiff company. There was considerable danger attaching to the way in which the plaintiffs had done their work, and the defendant only had a limited use of the light. They could not tell when a short circuit might take place. There had been short circuits.

The jury said they were of opinion that the plaintiffs were not entitled to any more than the £95 which had been paid them on their claim, and they awarded defendant £25 damages on his counterclaim. Judgment was entered accordingly.

GAMBRELL'S ENCLOSED PLUG RESISTANCE BOXES.

These resistance boxes are provided with blocks and plugs mounted on an ebonite board as in the ordinary pattern, but the blocks are enclosed by a hinged cover, and only the plug heads extend outside the case. The plugs cannot get lost, as immediately a plug is released from the blocks it flies to the top of the lid by means of a spiral spring and remains out of circuit. This also prevents errors arising through loose plugs. No dust can get into the instrument, as there are two covers over the blocks. Another feature is that each plug is always kept in the same hole. In the best class of instruments of this type an ebonite top is used in place of the ebonite bushed mahogany lid, and for sub-divided high resistances of 10,000 ohms and upwards, where the insulation is of great importance, ebonite pillars hollowed out to receive the German silver springs necessary for controlling the action of the plugs are fixed on the cover. The brass blocks in these high resistance instruments are mounted on ebonite blocks to ensure good insulation from block to block. The general arrangement (which is a decidedly good one) of the resistance box is shown by the illustration.

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BUSINESS NOTES.

Electrical Wares Exported.

Week ending Mar. 6th, 1900.		Week ending Mar. 5th, 1901.	
Adelaide	Value £264	Adelaide	Value £85
Amsterdam	60	Alexandria	95
Auckland	20	Amsterdam	129
Azores. Teleg. mat.	2,134	Auckland	49
Bombay	86	Buenos Ayres	3,548
,, Teleg. wire	105	,, Teleg. wire ..	490
Buenos Ayres. Teleg. mat. ..	193	Calcutta	325
,, Teleg. wire ..	186	Cape Town	492
,, ...	200	Colombo	246
Calcutta	301	Copenhagen	14
Christiania. Teleg. wire ..	21	Durban	697
Colombo	313	Gibraltar	40
Copenhagen. Teleg. cable ..	259	Gothenburg	23
,, Teleg. wire ..	22	Hamburg. Teleg. mat.	300
Demerara	52	Hong Kong. Teleg. apparatus	1,175
Durban	1,281	Kobe. Teleg. cable	1,412
,, Teleg. mat.	763	Kure. Teleg. cable	6,532
,, Teleph. mat.	161	Launceston	184
East London	29	Madras. Elec. tramway parts	285
Ghent	33	Melbourne	547
Gibraltar	20	,, Teleg. mat.	2,943
Gothenburg. Teleg. wire ..	110	Monte Video	1,445
Halifax	25	Perth	96
,, Teleg. cable ..	111,300	Rio Janeiro	89
Hamburg	10	Singapore	33
Kobe. Teleg. cable	737	Sydney	40
Mauritius	42	Syra	7
Melbourne	270	Trinidad	14
,, Elec. cable	450	Valparaiso	66
,, Teleph.	385	Vigo	28
Ostend	107	Wellington	151
Port Elizabeth. Teleg. mat. ..	1,377		
Rio Janeiro	64		
Rotterdam. Teleg. mat. ..	300		
Saigon	696		
Singapore	298		
Sydney	1,698		
Valparaiso	60		
Wellington	614		
,, Teleg. mat. ..	347		
Yokohama	560		
Total ..	£125,753	Total ..	£21,525

Foreign Goods Transhipped.

Malaga. Elec. light mat.	Value £86	Channel Islands	
Rio Janeiro. Elect. mat.	.. 57	235 cwt. creosoted teleph. poles	—
Trinidad. Teleph. mat. ..	.. 65		
Total ..	.. £208		

Application for Extension of Patent.—Mr. S. Z. de Ferranti is presenting a petition to His Majesty in Council for an extension of patent No. 12,419, dated September 13th, 1887—"Improvements in Electric Railways."

Books Received.—"L'Année Electrique," by Dr. Foveau de Courmelles. Paris: Librairie Polytechnique, Ch. Béranger, 1901, 3 fr. 50.

"Engineering Estimates and Cost Accounts," by Francis G. Burton, second edition, 1900. Manchester: The Technical Publishing Company, Limited. 3s. net.

Catalogues and Lists.—Messrs. Ernest Hutton & Co., Limited, of Ohm Works, Northallerton, send us an illustrated list of their multipolar dynamos and electric motors for low and moderate speeds. The several parts of the machines are shown separately, and prices and other particulars are given.

The Electrical Trades Supply, Limited, of Birmingham, are circulating a priced sheet of their h.v. tumbler switches.

A list of arc lamps and accessories has been issued by Messrs. Smithson, Sharpe & Co., of Manchester. The 1901 pattern vertical and inverted differential arc lamps are described, and compensating resistances, lamp elevators, choking coils and transformers are priced.

List No. 88 of the British Thomson-Houston Company describes the Thomson inclined coil measuring instruments. For the benefit of those who place these lists on file an index has now been issued.

The G.E. Co.'s List No. 31 describes their electric hand-drilling machine, bell pushes, and other specialities. The G.E. Co. also send us a copy of their March "Progress" sheet, giving a few details of their new high voltage wall socket, with "lined chamber" fuse, their "quick-break" tumbler switch with protecting wall of porcelain, and their new anti-vibration holder for use on traction systems, in theatres, &c.

Messrs. Mather & Platt have issued the first number of an excellent little eight-page pamphlet entitled "The Electrical Bulletin," in which they propose to describe from time to time some of the examples of electrical work carried on at their Salford Iron Works. Views appear of the yoke ring and armature of one of the 800-kw. machines which are being supplied to the Salford Corporation; a motor-driven feed pump and electrical conveyer are also described.

A list of shunt motors stocked by Messrs. Rosling, Appleby and Fynn, Limited, has been sent to us.

Deed of Assignment.—A first dividend is to be declared in the matter of a deed of assignment executed in November, 1900, by G. Margetts, of 53, Brown Street, Manchester, electrician and electrical engineer.

Egypt.—There has been a considerable increase in electric plant during the last three years, says *Commercial Intelligence*, and in 1899 the total value imported amounted to £66,580. Of this total France supplied plant to the value of £24,980, the United Kingdom coming next with £16,515. During the first half of 1900 there was a slight falling off. There is likely to be a growing demand for electrical apparatus, as the use of electric light, electric bells, &c., is spreading, and telephonic communication is being extended.

Dissolutions.—Messrs. G. D. Impey and W. A. Baxter (Baxter, Impey & Co., electrical engineers, Dudley Street, Birmingham) have dissolved partnership.

The partnership hitherto existing between Mr. Frederic H. Taylor and Mr. J. Hermann Field has been dissolved by mutual consent. Mr. Frederic Taylor continues as previously.

Electric Tramway Equipment Contracts.—Messrs. R. W. Blackwell & Co., Limited, have lately secured the following contracts:—From the Bradford Corporation for the overhead electrical equipment of the Idle and Thackley, Clayton and Queensbery and Fairsley sections of the Corporation tramways. From the Southampton Corporation for the overhead electrical equipment of the Canute Road, Dock Station to Avenue and St. Mary Street sections of the Corporation tramways. From the Brighton Corporation for the supply of their traction switchboard and the overhead electrical equipment of their tramway system. From the Southport Corporation for the supply of all the poles and brackets required for the extensions of the Corporation tramways. From the Manchester Corporation for all the material required for the overhead equipment of their new car shed. From the Manchester Corporation for tower wagons, reel wagons, and all the necessary tools required by the tramways department for carrying out extensions of their line.

For Sale.—The Dudley Electrical Committee is offering for sale two belt-driven 100-kw. railway generators (British Westinghouse) resistances, gear and belts for ditto; a Westinghouse enclosed engine for driving 100-kw. machine, and a wrought-iron stack. See "Official Notices" to-day.

The G.E.C. Staff Dinner.—Last Saturday the eleventh annual dinner of the General Electric Company, Limited, was held at the Hotel Cecil, and the directors provided for their staff and guests a most enjoyable evening. The company numbered over 300 guests, and amongst them were Prof. Perry, Colonel Crompton, Mr. Raworth, Mr. Roger Wallace, K.C., Mr. Manville, Mr. A. H. Preece, Mr. Musgrave Heaphy, Mr. Sinclair, Captain Lloyd, and many others.

Dinner was served in the Grand Hall, where Ashton's Blue Band performed an excellent programme of music. Mr. Max Byng presided. After the usual loyal toast, Mr. Eckstein proposed the health of the Imperial Forces, coupling the names of Colonel Crompton and Captain Lloyd. These gentlemen, in replying, testified to the efficiency of the men they had to lead, and Captain Lloyd mentioned the fact that he had made a raid on a stock of G.E.C. goods at Johannesburg on behalf of his commanding officer, and that he obtained delivery a great deal more quickly than he could in England. This remark called forth roars of laughter, and the company would not allow Captain Lloyd to qualify his statement.

Mr. Railing gave the toast of "Mr. G. Byng," which was received with acclamation, hoping for his speedy restoration to health, and in reply Mr. Max Byng read a letter from his brother to the staff. The keynote of this was a warning with regard to the militant commercial antagonism of other countries against England, pointing out that the directors had foreseen this to some extent, and guarded themselves against it in their own business. It was a source of gratification to them that the G.E.C. were able to make articles which were made in no other country, and they had such confidence in themselves that they had bought a large tract of ground at Witton, on which shops were being erected for manufacturing the largest class of machinery.

Mr. Hirst departed from his usual custom of taking a serious subject for his speech, and, in toasting "The Staff," indulged in some clever and good-humoured chaff at their expense, from the office boys and commissionaire upwards to the sub. and general managers; he also announced that Mr. Bevis and Mr. Hawkins had been invited to join the board.

Mr. Brooker and Mr. Bevis having replied, Mr. Max Byng next proposed the health of "The Guests," coupling the names of Prof. Perry and Mr. Wallace. The President of the I.E.E., in replying, referred to the question of England's neglect of science about which he said he had been preaching; he hardly felt that those remarks would apply to the G.E.C., because from what he knew of its directors, they were all capable men in this respect, and the present position of the firm was due to their knowledge. He wished that some of the organisation which must prevail in up-to-date businesses like the G.E.C. could be adopted in certain Government departments of which he knew. He spoke in appreciative terms of Mr. Hirst, to whose services at the council table he paid a high compliment. Mr. Roger Wallace followed, and, speaking as a financial man, complained that the guests had not been allowed to take up some of the firm's ordinary shares.

The company then adjourned to the Victoria Hall, where the rest of the evening was spent in listening to an excellent smoking concert.

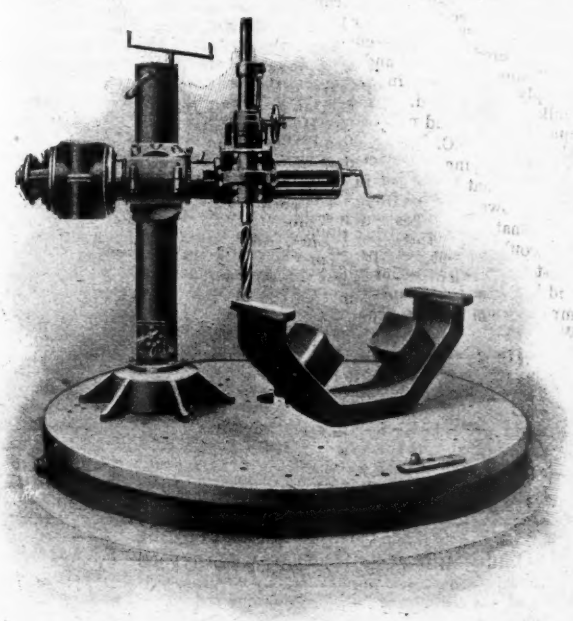
Glasgow Engineering Congress.—The local arrangements for this Congress are making rapid progress. The committee are fitting up a most elaborate guide to Glasgow, giving details of all the different engineering and kindred shops in the district, which, with the visits to works, will form one of the features of the Congress. The meetings are to be held in the University by permission of the Senate, the same being within easy access of the Exhibition.

Germany.—The Thuringer Electricitäts Gesellschaft is the name of a company which has just been formed in Berlin, with a capital of £50,000, to carry on an electrical engineering business.

Glasgow Exhibition.—Rapid progress is being made with the finishing of the Machinery Hall. So far the only electrical firm of standing to commence operations is a well-known German firm. Eighty of the Russian workmen have struck work for higher pay.

Kimberley.—Mr. Arthur McCracken has been appointed manager of Messrs. Reunert's electric department, in place of Mr. Granville Vines, resigned.

New Portable Drilling Machine.—This machine has been designed by Messrs. Mather & Platt with the special object of providing a convenient tool for drilling operations, where the expense of carrying the tool to the work is less than that of carrying the work to the tool. The machine is entirely self-contained, having no connection with any outside apparatus, except the electric leads. It may readily be set up, and can be detached, moved and started again with a minimum of delay. The spindle is driven by gearing from the motor shaft; the gear is of great strength, and the machine is capable of taking heavy cuts considering its size. Holes may be drilled in any direction, horizontal, vertical, or at any angle, with equal facility, and all adjusting clamps may be loosened at the same time, for the necessary adjustments, without fear of any part being over-balanced. Holding down bolts are dispensed with, as it is able to grip any bedplate or other convenient flat and smooth iron surface. As will be seen from the illustration, the machine consists of a main column fitted with a saddle, which carries a radial arm, on one end of which is mounted the drilling head with its spindle, and on the other end the driving motor. These parts are constructed to give three independent motions of the drill:—(1) The saddle and all parts carried by it can be swivelled in a complete circle round the main column in a horizontal plane; (2) the radial arm can be swivelled in a complete circle in a vertical plane; (3) the radial arm, and with it the drill spindle, can



be swivelled about its own axis through a complete circle in a plane perpendicular to the arm. Besides these motions the head can be traversed along the radial arm, and the saddle can be raised or lowered on the main column. The base of the drill is provided with an electro-magnetic arrangement, which holds the drill in position when placed on any flat and smooth surface of iron, and with a good contact, an adhesion of 3 tons can be obtained. For specially heavy work it is desirable to supplement the magnetic attachment by dogs to prevent creeping. The current for this magnet is taken from the same source as that used for driving the motor, the circuits being connected in such a way that the act of starting the motor magnetises the holding-down coil, thus preventing the tool shifting through carelessness. The main column is 7 ft. high, and 12 in. in diameter; the lower part of it contains the motor-starting resistance, which is thus effectively protected from injury. A screw runs the whole length of this column, carrying a crescent-shaped nut, which projects into a groove in the saddle, providing in this way a ready means of elevating the saddle, while leaving it entirely free to rotate round the column. The radial arm is 8 in. in diameter. The whole of the driving gear is contained in this arm, so that its position in no way affects the driving. The traversing motion of the drilling head is controlled by a screw in the usual way, and it is firmly clamped in position by an expanding wedge gib. The drill spindle is 3 in. in diameter, bored at the end for No. 5 Morse taper socket, and is provided with power feed by means of a sleeve driven with a pinion and two sets of worms and gears, directly off the spindle. After disconnecting the power feed by the clamping nut at the centre of the hand-wheel, the spindle may be fed by hand. The motor attached is of the Mather & Platt two-pole enclosed type, capable of developing 2 H.P. at 800 revolutions per minute, and is connected to the switch by a flexible cable. It can be wound as desired for working from a 100 or a 200-volt circuit. The motor shaft is prolonged so as to pass through the spiral gear, driving direct on to the drill spindle. This gear has a ratio of 9 to 1, and with back gears of 3 to 1 provided, it is possible to run the spindle either at 90 revolutions per minute or 30 revolutions per minute, with the motor running at full speed; slower speeds can be obtained by regulating the speed of the motor. The drill is suitable for boring holes up to 2½ in. diameter, and appears to us to be a thoroughly practical and up-to-date type of tool.

"Elblight."—A demonstration of the electric lighting board system took place at St. Petersburg last week before the Czar and the Russian Imperial Court, who were much interested.

Private Bills.—The following private Bills were read a second time in the Commons on Monday:—Bury Corporation Tramways, Caledonian Electric Power, Cleveland and Durham County Electric Power, Clyde Valley Electrical Power, Derbyshire and Nottinghamshire Electric Power, Shannon Water and Electric Power, Stalybridge, Hyde, Mossley, and Dukinfield Tramways and Electricity Board, and Yorkshire Electric Power Bill.

Switchboard Platform Lights.—Messrs. Hayward Bros. & Eckstein, Limited, of Union Street, Borough, S.E., have lately invented a glass floor light for use in electricity works where a perfectly insulated switchboard platform is required, which at the same time will thoroughly light the area below. The frame, in which the lenses are set, is made strong enough to stand any foot traffic. The lenses themselves are set as closely together as is practicable; the joints between them are run in with a specially prepared non-conducting compcsition. Already these lights are in use at the Glasgow, Brighton, Wallsend-on-Tyne and other electricity supply works, and are understood to be giving satisfaction. The firm has issued a list in which the invention is described, along with street box frames and covers, wrought-iron staircases and doors, and other specialities for electricity works.

Trade Announcements.—Messrs. Johnson & Phillips's electric cable works have opened a West End depôt for their cables, at 37, King Street, Covent Garden, W.C. A large stock of all the standard sizes and qualities will be kept for immediate delivery.

The lease of their works having expired, Messrs. Harry South and Co. are building new premises, to which they will shortly remove their offices, showrooms, &c. In consequence they are now inviting offers for the lease of 10 and 12, Garrick Street.

ELECTRIC LIGHT AND POWER NOTES.

Aldershot.—An inquiry was held by Colonel W. L. Coke, A.M.I.C.E., inspector of the L.G.B., at Aldershot last month, into the application of the Council for leave to raise a loan for electric lighting works The Council already has a prov. order, and has practically accepted the tender of Messrs. Thomas Parker to carry out the whole of the work for £14,466. The proposed installation will provide for 8,000 lamps. There was no opposition.

Arbroath.—The T.C. has resolved to apply to the Secretary for Scotland for a prov. order conferring powers upon the Council to borrow a sum not exceeding £40,000, for the purpose of introducing the electric light into Arbroath.

Barrow.—The City Council has decided to extend the electric lighting system to Vickerstown, on Walney Island, at a cost for cables of £6,207, the Walney Estates Company guaranteeing an annual revenue of £1,000.

Ballycastle.—Steps are being taken with a view to the introduction of the electric light into the town.

Bath.—The E.L. Committee has accepted Mr. Metzger's resignation, and out of 50 applicants for the post has selected the following:—Messrs. Teague, of Paisley; Sayer, of Hampstead; and Pullen, of Ealing. The E.L. Committee has since decided to recommend the appointment of Mr. Teague, of Paisley, as city electrical engineer, at a salary of £350 per annum.

Bridlington.—The T.C. is inviting quotations from firms willing to carry out its E.L. provisional order.

Burnley.—The Electricity Sub-Committee has resolved to recommend the adoption of a flat rate of 4d. per unit for electrical energy.

Cologne (Germany).—The T.C. has voted a sum of £18,400 for the acquisition of two dynamos of 1,000 KW. each for the use of the municipal power station.

Coventry.—The number of consumers of electricity on December 31st, 1900, was 328, and the income for the December quarter, £2,005, as compared with 198, and £1,341 in the preceding year.

At a special meeting of the E.L. Committee of the Corporation last week, a letter was read from Mr. G. S. Ram, resigning the position of electrical engineer, consequent upon his having accepted an appointment in London. The resignation was accepted with regret.

Croydon.—The borough electrical engineer reported last week that the extra-high-pressure main to Upper Norwood, laid in the autumn of 1898, specified to work at a pressure of 5,000 volts, and to stand a test pressure of 10,000 volts, notwithstanding its having successfully withstood this test at the works, does not now, as laid, meet the requirements of the specification; the contractors had now expressed their willingness to lay a new cable, in accordance with the specification, from the Central Station to Upper Norwood, free of cost, the Corporation to pay for the excavation only, and the old cable being left in the ground, the property of the Corporation. This offer was accepted.

Derby.—Mr. H. P. Boulnois, M.Inst.C.E., inspector of the L.G.B. held an inquiry at Derby last week into an application by the T.C. for sanction to borrow £35,850 for electric lighting purposes. The amount is required for new machinery and mains. The present installation is incapable of meeting the demands for the supply of electricity, and new machinery is being laid down and extensions made to the present station for the proposed supply of energy for electric traction throughout the town. There was no opposition to the application.

Dublin.—The lighting of Dublin seems a very hard matter to decide upon, and great difficulty has been experienced as to the erection of a power station at the Pigeon House. When the first tenders were made according to Mr. Hammond's specification, it was found that they were all far in excess of the sum which had been fixed as the probable cost of the work. Mr. Hammond was then asked to cut down his original specification, and new tenders were invited. As a consequence the following remarkable reductions were made in the estimates laid before the E.L. Committee. The figures are as follows:—

	Original.	Amended.
J. and P. Good	£47,500	£32,671 6 7
Pearson	52,900	46 926 5 2
H and J. Martin	47,000	31,668 16 10
J. and W. Stewart, Belfast	41,674	29,051 10 9

It is probable that the lowest tender—that of Messrs. Stewart, of Belfast—will be accepted, though it is more than £9,000 in excess of the original estimate.

Dudley.—The E.L. Committee have resolved to abandon the free wiring scheme, on account of the opposition of the L.G.B. The price for electrical energy recommended is 5d. per unit throughout, or 6d. per unit for the first two hours' use per day of the maximum demand, and 1½d. per unit afterwards; no rental to be charged for meters.

The E.L. Committee recommends that Mr. R. P. Wilson, consulting engineer, be retained as chief engineer at a salary of £300 per annum, he providing and paying two assistant engineers.

Dumfries.—At a meeting of the E.L. Committee of the T.C. last week it was resolved to invite Mr. Ritchie, engineer, Edinburgh, as an expert on the question of turbines, to visit the Glen River, and report upon its adaptability to the generation of electricity for the supply of the town, and to report on any other source of water-power in the district which may appear to him to be available.

Glasgow.—A curious state of things reigns in the model city. The charges for electricity are 6d. for the first hour and 1½d. afterwards, but a consumer who guarantees to use his maximum demand five hours per day the year round is charged 1½d. per unit only. Hence a three or four-hour consumer actually makes a profit by keeping his maximum load on for *five* hours, whether he wants the energy or not! According to one of the Councillors, Mr. Burrell, this has become known, and is being done by some of the acute business men of Glasgow.

Eccles.—The deficiency on the electricity accounts amounts to £855, which will fall on the rates.

Exeter.—Provision is being made for the supply of direct current for power purposes, in the plans of the new electricity works.

Halifax.—During the past week the two rival electrical supply companies for Yorkshire, who are promoting Parliamentary Bills, have been interviewing the Halifax authorities, the Chamber of Commerce, and the Electricity Committee of the Corporation, with a view to getting them to support their Bills. The Yorkshire Supply Company sent a deputation to the Chamber of Commerce, with Mr. Baker, their consulting engineer, as their spokesman. Mr. Baker briefly unfolded his scheme, pointing out that the company would supply electricity in bulk and leave the distributing work to local authorities. As regards Halifax, their proposals for competing with the local authorities simply amounted to this—that in circumstances where the Corporation found it impossible to supply they should come in and help them. He said, however, in reply to the town clerk, that the company would certainly not be prepared to insert a clause in their Bill to the effect that with or without the consent of the Board of Trade they would not supply within the Halifax area against the wishes of the Corporation. The deputation from the South Yorkshire Company also had an interview, and Mr. Clirehugh, of Manchester, their engineer, was the spokesman. He pointed out that although the supply in bulk from their company might not appear to be as cheap as the proposals of the rival company, yet the tariff to miscellaneous consumers was lower than that of the Yorkshire Company. It subsequently transpired that Mr. Clirehugh and his deputation had a prior interview with members of the Electricity Committee, at which they agreed to insert the clause which the deputation from the Yorkshire Company declined. The Chamber of Commerce decided to refer the subject to a special committee, but it was clear that the local mill owners favour competition as against the exclusive position taken up by the Corporation. The Corporation will enter opposition against both Bills, but the Electricity Committee favours the Yorkshire Company, and negotiations are already proceeding with the latter company with a view to the concession of certain points contingent on opposition being withdrawn.

Ham.—The D.C. has agreed to the application of the Richmond E.L. Co. for a provisional order for the electric lighting of the district.

Hendon.—In response to inquiries addressed by the D.C. to the following bodies asking for terms as to the supply of electrical energy in bulk, the replies received were:—

Hampstead Borough Council, 5d. per unit.

Charing Cross, Euston and Hampstead Railway, 3d. per unit.

North Metropolitan Electric Supply Company, 4d. and 2d. per unit, which would average about 2¼d. on a demand of about 120,000 units per annum.

On Wednesday last week Mr. Hammond addressed a meeting of ratepayers and owners on the subject of the proposed electric lighting scheme for Hendon. The plant is to consist of three 30 ft. × 8 ft. Lancashire boilers, with mechanical stokers; four 75-KW. dynamos direct coupled to steam engines; a condensing plant, battery of storage cells, motor transformers, &c. The supply would be on the three-wire direct-current system, with 480 volts between the outers. The feeders and distributors are to be concentric and lead-covered, and run in earthenware conduits, filled up with a bituminous compound. The North Metropolitan Electric Power Supply Company had powers to supply this district with energy in bulk, and the D.C. had given their careful consideration to the question of buying energy from the company, but he had advised the Council that he did not think it would pay them to get a supply from the Power Company. He had estimated that on the proposed total estimate of £36,400, a saving of £10 000 on the capital expenditure could be effected, which would reduce the repayments of interest and sinking fund by £575, while the working expenses would be reduced from £2,500 to £1,300 per annum. The Supply Company's charges would come out at about 2¾d. per unit.

We are informed that the prevailing feeling in the district is that Hendon is not yet ripe for such a scheme, which will entail the laying down of about 8¼ miles of mains, a good proportion of which would be in an unremunerative part of the district, and that an extension of time should be sought from the B. of T.

Italy.—Mr. Achille Bertelli, and the engineer, Giovanni Quarera, have presented to the Italian Minister of Public Works a project with a request for concession of a canal to be supplied by the Chiese and running through the communes of Vestone, Mazza, and Barghe, in the Sabbia valley, province of Brescia. The object of the canal is to secure a waterfall for the development of electrical energy. The take of water would be at the rate of 80 cubic metres per minute, and is calculated with a fall of 20·3 metres to develop 2,231 H.P. The cost of the projected works is estimated at 450,000 lires.

Kidderminster.—Messrs. Whittaker & Co., of Dudley, have just completed the installation of electric light in the municipal and Town Hall buildings, the Free Library and schools of science and art. The electric light is making considerable progress in the borough.

Leith.—The E.L. Committee of the T.C. intends to increase the generating plant, and to reduce the charges for supply.

London.—L.C.C.—The Council last week resolved to sanction the borrowing by the Battersea Borough Council of £10,600 for the purpose of additional lighting mains.

The Highways Committee reported that notices had been served by the Charing Cross and Strand Electricity Supply Corporation of intention to lay mains in various streets. It appeared that the company proposed to appropriate very large spaces under the thoroughfares specified in the notices, and to construct principally under the public way a large street box 11 ft. 6 in. long, 10 ft. broad, and 9 ft. deep immediately in front of its new premises now being erected in St. Martin's Lane. The Council has repeatedly taken exception to the construction by electric lighting companies of large boxes under the public thoroughfares, and withheld its consent to the works projected in the present instance.

St. Pancras.—The Borough Council has decided to approve an extensive scheme for providing additional arc lamps in many parts of the district. According to a report submitted by Mr. S. W. Baynes, chief electrical engineer, the expenditure would amount to £69,112. When the light has been installed in the streets enumerated, there will be 567 additional arc lamps, or a total of 985 arc lamps throughout the borough. It will take some two years

to carry out the scheme, even with an increased outdoor staff, as it is only during the summer months that street work of this kind can be carried out.

Stepney.—The Finance Committee recently presented a report to the Borough Council stating that they had considered the question of the proposed laying of electric mains by the E.L. Committee for the Whitechapel district, by the Post Office authorities and the Charing Cross and Strand Electricity Supply Corporation in the Commercial, Whitechapel and Mile End Roads, and, in view of the fact that it had been found impossible for the borough engineer to arrive at a definite understanding with the engineers of the authority and the body who have obtained statutory powers for laying mains in the roads in question, they recommended that so much of the footway pavements as extend 5 ft. from the houses should be at once reserved for the purpose of laying the electric mains necessary for the Council's installation in the borough. The report was adopted.

Shoreditch.—The Lighting Committee of the Borough Council has reported having considered an estimate of the consulting engineers for the supply and erection of constructional iron and steel work for the new generating station in Whiston Street, including overhead coal bunkers, elevator tower, coal-handling plant, &c., at a cost of £7,000. The Council decided to proceed with the construction of a cable tunnel from the new station under the canal to the corner of Great Cambridge Street.

Stepney.—The Borough Council has resolved to borrow £122,200 for carrying out the electric lighting of the borough. The electrical engineer to the borough estimates that 100 miles of cable will be laid, 20 miles of trenching undertaken, and 280 arc lamps erected.

Manchester.—The Electricity Committee of the Corporation has given notice that all new applications for electricity supply must be refused until the Bloom Street station is completed some time next year. It is understood that this step has been taken in order to avoid the other alternative, viz., to delay the running of the electric cars until the new station is ready. The arrangement will press hardly on those who have built houses with electric wiring in place of gas pipes, or laid out new works for electric driving, under the impression that the Corporation would fulfil its duties. It would seem that the ordinary or would-be consumers have the first claim upon the electricity supply, and the opening of the tramways ought therefore to have been postponed until power was available for them without inconvenience to individual consumers. The electrical engineers and contractors of Manchester will necessarily be amongst the chief sufferers from this step. The question has been raised whether the action of the Corporation is legally permissible, and it is suggested that the Corporation, or its Electricity Committee, has rendered itself liable to heavy penalties thereby.

Milton.—A meeting of the Ratepayers' Association was addressed by Mr. Offer on behalf of the Kent Electrical Distribution Company last week.

Newcastle.—The Corporation having applied for sanction to borrow £10,000, Mr. A. A. G. Malet, A.M.I.C.E., L.G.B. inspector, held an inquiry last week into the subject. The loan was needed for the purpose of lighting by electricity the principal thoroughfares in the centre of the city in which the tramways were being electrically equipped.

Newport.—When the Corporation Bill, 1900, went through Parliament, the estimated expenditure on the new power station and the equipment of the lines for electric traction was £130,000, but later in the same session the South Wales Power Bill was passed and changed the position. Under that Bill the company obtained the right to come into Newport and supply power, provided it was shown, at the expiration of four years, that the Corporation was not in a position to supply current for power purposes. Instead, therefore, of providing for three sets of plant of 250 kw. each, the Corporation proposes to set up three sets of 500 kw. capacity each. Combined with this will be the necessity of laying down a large number of ducts for conveying the cables for power distribution generally. The additional cost will be £70,000, thus increasing the original estimate to £200,000.

The Electricity Committee of the Corporation has just accepted a tender for the supply of small coal. The price is eloquent of the change in the past six months. In September last the contract was entered into at 17s. 6d. per ton; last week the accepted tender was 6s. per ton.

North Metropolitan District (East Middlesex).—The adverse voting of the ratepayers at Enfield and Edmonton has resulted in the total collapse of the joint schemes of the District Councils. Wood Green and Tottenham have now dropped it, and only Southgate remains. These five districts are to be congratulated upon the sound sense displayed by the ratepayers of Enfield and Edmonton; it is to be hoped that they will not throw away the fruits thereof by endeavouring to obtain prov. orders independently, though Tottenham D.C. has already passed a resolution to do so.

Nottingham.—The new electric lighting works which the Midland Railway Company are erecting are on a very much larger scale than their existing generating station. The new station is about 230 ft. long and 50 ft. in width. The railway company is also rebuilding the central passenger station; the scheme is an extensive one, involving an outlay of over half a million sterling, and the buildings will be illuminated throughout with electric light.

Oldham.—Mr. R. H. Bicknell, L.G.B. inspector, held an inquiry at Oldham last week into the application of the Borough Council for sanction to borrow £157,000 for the purpose of electric lighting and traction. The first order to supply electricity was obtained in 1890, and the Corporation had made five applications for borrowing powers, obtaining in all £88,000. In 1899 they obtained an Act authorising the laying of tramways 12 miles in length, within the borough, to be worked by electricity. About 8 miles had already been laid, nearly the whole of which had been equipped, and a portion had been worked since December 15th last. There were at present two companies running cars in the borough, whose leases would expire on October 31st next, after which the Corporation would begin to equip the main lines for electric cars. The total length of the old and new lines would be about 25 miles. Prof. Kennedy explained the scheme for the electric light station, and said that it was estimated that for the year ending March 25th next there would be about 610,000 units output.

Pengam.—At the last meeting of the Bedwellty D.C. at Pengam, Mr. R. Gold moved that an expert be engaged to report upon the cost of an electric light scheme for the whole of the Rhymney Valley area of the Council's district.

Rochdale.—Mr. Lacey's report to the T.C. on the use of refuse for generating steam for electric traction shows that the complete destructor plant (nine cells and three Lancashire boilers), together with two coal-fired boilers, engines and dynamos of 1,200-kw. output, and all accessories, would cost about £33,572. There would be 60 cars. The report states that to purchase electrical energy from the Electricity Committee would cost about the same as to generate it from refuse. A report was also submitted by Mr. Brookman, manager of the sanitary works, suggesting various modifications in favour of the refuse destructor scheme, and advocating joint working with the lighting station.

St. Anne's.—The electric street lighting was turned on for the first time last week.

Sunderland.—Mr. M. K. North, A.M.I.C.E., L.G.B. inspector, visited Sunderland last week for the purpose of inquiring into the application of the Corporation for power to borrow the sum of £73,035 for the extension of the electric lighting and power station. In the course of the evidence it was stated that the present station, situate in Dunning Street, and which had itself been extended, had now reached the limit of its capacity, and the Corporation had had to refuse to take on something like 50 consumers. With the exception of some £18,600, which has already been spent on the extensions of the mains, the whole of the new loan is to be laid out on the erection of a new generating station. The items of expenditure are £20,950 for the building, £9,260 for boilers, pumps, economisers, &c., £23,010 for two 200-h.p. and three 450-h.p. dynamos, £1,200 for switchboard, &c., £18,615 extensions to mains, cables, feeders, &c. The new station will be entirely devoted to the supply of electricity for lighting purposes, and the Dunning Street station to the supply of energy for the tramway system. Mr. Snell, the borough electrician, said the consumption for the half-year ending September 30th, 1899, was 197,000 units, as against 289,000 units for the corresponding half of last year, whereas from September 30th, 1900, to that date (February 21st) the output was 630,000 units, and the estimate for the year would be not less than 1,200,000 units. There was no opposition to the scheme. The proposal to use one station for power and the other for lighting throws a curious light upon the vaunted economy of combined stations, improvement of load factor, &c. We cannot refrain from pointing out how this move confirms our contention—that such economy is practically confined to small stations.

Taunton.—The T.C. has passed the proposal to apply for leave to borrow £17,800 for extensions of the electricity works.

Todmorden.—The T.C. has decided to oppose the Yorkshire Power Bills and to promote a Bill on its own account.

West Bromwich.—On Friday last Mr. H. P. Boulnois, M.I.C.E., held an inquiry on behalf of the L.G.B. concerning the T.C.'s application to borrow £10,000 for electrical purposes. The town clerk stated that the Council had power, under its Act, to supply electrical fittings, and to undertake the wiring of houses. Mr. R. C. Quin's estimate showed that the capital would be spent in two years from the date of commencement. The sum of £5,000 was required for the hiring of motors, and a similar amount was needed to wire the houses and purchase the necessary materials. The Corporation were undertaking the work of supplying fittings and the wiring of houses, because they considered it would be more satisfactory to the consumers and themselves. At the present time they had a contract for the labour in respect of the wiring of the houses, but the Corporation would purchase the materials. They did not anticipate any difficulty in securing applications for this kind of work, although private individuals were at present competing with them; in fact, an extensive canvass for the supply of fittings and the wiring of houses was now going on in the borough. No one opposed the application—a strange thing, seeing that the Corporation is evidently entering into direct competition with wiring contractors.

Woking.—A public meeting of the ratepayers has passed a unanimous resolution protesting against the recent decision of the U.D.C. in favour of gas instead of electricity for public lighting.

Belgium.—A company has just been formed with a capital of £20,000, to be known as La Société Nouvelle du Centre d'Anvers to establish a central electric lighting and power station in Antwerp.

Bury St. Edmunds. — The public lighting of the principal streets with arc lamps was formally inaugurated last week.

Dorking.—The negotiations for the transfer of the recently-acquired provisional order, from the U.D.C. to the West London and Provincial Electric Supply Company, are nearly completed.

Germany.—A large electric power generating station is being established near Mihla to utilise the water-power of the River Werra.

Middlesbrough.—The North-Eastern Railway Company have settled a contract with Messrs. Cowans, Sheldon & Co., of Carlisle, for the supply of 30 electric cranes, 17 of which are 3 tons, and 3 of 10 tons, as well as 24 electric capstans. An electric station is being erected at the docks for supplying motive power for the cranes, and when the installation is finished it will be one of the most complete in the country.

Niagara Falls.—The Niagara Falls Power Company recently decided to carry out a large extension of the power house at the Falls, and a correspondent of the *Financier* now states that the proposal elaborated by Escher Wyss, of Zurich, for the supply of several gigantic turbines for driving the new alternators has just been adopted by the company. The contract provides for the delivery of six turbines, each of 5,500 H.P., or a total of 33,000 H.P. As, however, the United States tariff would prevent the delivery of the turbines as a whole, it is intended to construct only certain parts of the machines in Switzerland, whilst the remainder will have to be built in the United States according to the plans of the Swiss company.

Sea Point (S.A.).—At a recent meeting of the Sea Point Municipal Council a petition signed by a number of local residents was read, drawing attention to the absence of electric lighting. They urged that a scheme of lighting be considered. The Mayor said he thought the petition, which was an influential one, should have serious consideration. It was decided to refer the matter to the Public Works Committee for report.

The Council adopted a report presented by the Public Works Committee advocating the expediting of a Bill for the electrification of the Sea Point Railway.

Spain.—A central electrical lighting station has just been completed in the town of San Mateo de Gallego. Water power is utilised.

Wells.—The T.C. has received a letter from the B. of T. threatening to revoke the Council's prov. order for electric lighting.

Worcester.—The electricity accounts for 1900 show total revenue, £8,981; total costs, £5,999; gross surplus, £3,670; £3,666 was set aside for sinking fund and interest.

York.—The L.G.B. has sanctioned the borrowing of the sum of £20,000 by the Corporation for electric lighting purposes.

Yorkshire Power Schemes.—The Halifax Chamber of Commerce received deputations from the two companies last week. Mr. Clirehugh addressed the Chamber on behalf of the South Yorkshire scheme, and Mr. C. A. Baker spoke for the Yorkshire Electrical Supply Company.

A joint meeting of representatives of District Councils was addressed by Mr. Clirehugh on behalf of the South Yorkshire Electrical Power Company last week.

The promoters of this Bill held a conference with the Chamber of Commerce of Wakefield last week, and afterwards with representatives of the non-county boroughs in the West Riding, whose interests are affected by the Bill.

ELECTRIC TRACTION NOTES.

Bilston.—At the monthly meeting of the U.D.C. last week, assent was given to the transfer of the old Wolverhampton Tramway Company's undertaking in Bilston to the Wolverhampton District Electric Tramway, Limited, at the price of £9,582.

Burnley.—The Corporation has purchased the tramway company's undertaking for £53,000, and intends to spend £120,000 in relaying the lines and providing electrical equipment.

Cardiff.—Negotiations are in progress between the Corporation and the tramways company, in order to bring about the reconstruction of the track for electric traction by the company at the expense of the Corporation at once, instead of waiting until January next, when the Corporation has power to purchase the undertaking.

Carnarvon.—An inquiry was held by Mr. Trotter on behalf of the B. of T. on Tuesday last week, into the application of Mr. Peterson for a prov. order for the electric lighting of Carnarvon. The Corporation opposed, stating that Mr. Peterson had pledged himself to construct a light railway to Dinas Dinlle. Much evidence was led on both sides.

Dublin.—At the half-yearly general meeting of the Clontarf and Hill of Howth Tramroad Company on Tuesday, February 26th, the chairman, Sir F. Brady, said that from the opening of the line on July 26th to December 31st last the total receipts were £2,857, and the number of passengers carried 255,454. The largest receipts in one day were £338 and the lowest £27. After paying all expenses, including £386, compensation for accidents, there remained a net profit of £666, which was carried to next account.

Dundee.—At a meeting of the Tramway Committee of the T.C. last Monday tenders were submitted by the electrical engineer for conduits for electric cables, and the offer of Doulton & Co., amounting to £823 5s., was recommended to be accepted. A new engine is to be obtained to provide additional power at the electric station. To provide against the possibility of accident from the overhead electric current, Mr. Fisher has devised an important precautionary measure. Each driver of a car has been provided with a piece of insulated cable, and on each vehicle is carried a bamboo cane. With this simple apparatus the driver can deaden the trolley wire within the section. All he has to do in the event of an accident is to place one end of the cable on one of the rails, and by means of the cane, fix the other end on the overhead wire. So soon as the connection is completed, the circuit-breaker at the station is thrown out, and it cannot again be put into working order until the driver of the car has released the cable from contact with the trolley wire and the rail. The cars on the particular section of the system are, of course, brought to a standstill. The operation can be performed in a few seconds, and the importance of it cannot be over-estimated. It is simple and effective.

Durban (Natal).—On January 21st Mr. Panton, Deputy-Mayor, laid the first rails of the electric tramways, which, it is expected, will be built within the next 14 months.

Garston.—At a meeting of property owners and ratepayers of Garston and district on the 4th inst., the decision of the Council to oppose the Manchester and Liverpool Electric Express Railway Bill in Parliament was endorsed by four to one.

High Speed Transit.—A correspondent of the *Daily Mail* reports a recent interview with Messrs. Siemens & Halske with regard to high speed electric trains; they claim to have carried out very extensive experiments in this connection, but as their experimental line is only 2 km. (1¼ miles) in length, the trains have to stop when they attain a speed of 60 km. (37½ miles) per hour. A sum of £37,500 has been subscribed by leading manufacturers and bankers towards the expense of the experiment, and the Ministers of War and Railways have lent the military line between Berlin and Zossen, 33 km. (20½ miles) long, as well as engines and wagons, and soldiers to guard the line. The electric "engines" are to run at a speed of 114 miles an hour. One is being built at Messrs. Siemens's works, another by Mr. Van der Zypen in Cologne, and they are to be ready for trial in the early autumn.

The Elevated Electric Railway in Berlin is to be opened on January 1st, 1902, and is said to be full of new inventions and appliances. The trains are to run at 30 km. (18·75 miles) per hour, which is said to be faster than the trains in New York and London—but this we doubt. After the Elevated Railway is finished, the firm intend to build an underground railway parallel with the main thoroughfare of Berlin. The interviewer was also informed of great improvements effected by the firm in the manufacture of telephone cable, and a new system of telephony which appears to resemble the central battery system adopted by the British Post Office.

Isle of Thanet.—It is stated that the Isle of Thanet Light Railway Company hopes to start the service of electric tramcars at Easter.

Kingston-on-Thames.—After a good deal of unproductive negotiations on both sides, the Corporation and the London United Tramways Company have agreed to meet in conference as to the company's terms to the borough on the withdrawal of the latter's opposition to the company's tramway scheme.

Liverpool.—In accordance with the recommendations made by Mr. A. B. Holmes, city electrical engineer, the Tramways Committee of the City Council have given instructions for an adequate supply of india-rubber gloves to be provided and distributed among the various police stations, so as to be available in the event of any further falls of electrical wires. The Tramways Committee have also ordered a plan to be prepared showing the wires at present existing over the tramway lines, and the owners of the same, as far as can be ascertained, and that the engineers do report as to the position of the Corporation with respect to such wires.

Last week, a small boy was charged in the Liverpool Police Court with stealing an incandescent lamp from one of the electric cars. The boy was one of a number of boys who admitted that they had taken from 20 to 30 incandescent lamps from cars whilst the conductors were busy. The magistrates remarked upon the danger of the practice and fined the boy 1s. and 1s. costs.

London-Brighton.—It is rumoured that an electric railway between London and Brighton is projected, Mr. T. L. Johnson being the chief promoter. High speed electric trains are to be run, on the Sprague multiple unit system.

London Underground Electric Railways.—In the House of Lords on Monday, on the motion of the Earl of Morley, it was resolved:—

That it is desirable that a Select Committee be appointed to join with a Committee of the House of Commons to consider and report:—(1) Whether the lines of route for underground railways in and near London, proposed by Bills which have been or may be introduced during the present Session, are best calculated to afford facilities for present and probable future traffic, and, if not, what modifications of those lines of route are desirable; (2) what special provisions, if any, should be made for the protection of the owners, lessees, and occupiers of properties adjacent to underground railways from possible damage and annoyance: (3) what special terms and conditions, if any, as to construction and working should be imposed upon the promoters: (4) whether any, and which, of the schemes proposed by the said Bills should not be proceeded with during the present Session.

In the House of Commons on the same day Mr. Bryce asked the President of the Board of Trade whether, in case His Majesty's Government proposed the appointment of a Committee to consider, in conjunction with a Committee of the other House, the best lines of route for underground railways in London, it would be proposed that all Bills for underground railways introduced in the present Session should be referred to such a Committee; and whether, in case of the appointment of such a Committee, His Majesty's Government would consider the desirability of letting the reference to it be sufficiently wide to allow the Committee to report upon the whole question of so arranging and connecting underground lines as to enable such lines to afford the *maximum* of relief to surface traffic, and to secure rapid transit from the central parts of London to the suburbs.

Mr. Gerald Balfour, in reply, said he hoped that the reference to the Committee would be so framed as to ensure that all the Bills of this Session dealing with underground railways in London shall be laid before it, and also that the Committee shall be invited to report whether the lines of route proposed are best calculated to afford facilities for present and probable future traffics, and, if not, what modifications of those lines of route are desirable.

London United Tramways Bill.—The Parliamentary Committee last week informed the L.C.C. that this Bill proposed the construction of 17½ miles of tramways within the County of London, and 27½ miles outside. Several of the proposed tramways are practically identical with lines for which the L.C.C. is seeking powers, whilst other lines correspond with lines which have been under the consideration of the Council. The Bill proposed to exempt the company's lines from the operation of Sec. 43 of the Tramways Act, 1870, and to substitute a clause enabling the local authorities referred to in the Bill to purchase the undertaking at the expiration of 25 years upon terms of paying the fair market value as a going concern. A recommendation was adopted refusing to consent to the construction of the lines proposed in the Metropolitan area.

The London United Tramways Company has, in compliance with the Standing Orders of Parliament, deposited a copy of its engineer's estimates of the cost of constructing the extensions proposed in its Bill for this session. The total cost of these extensions is put down at £665,943, but no provision is made or will be made this session for the granting by Parliament of any additional capital powers.

Metropolitan Railway Bills.—The L.C.C. last week resolved to oppose the Bills promoted by the Metropolitan District Railway Company and the British Westinghouse Electric Manufacturing Company.

New Malton.—The U.D.C. have sealed their agreement with the London United Tramways, Limited, by which the Council consent to the company's proposed tramways in their district on payment of £1,500 and sundry minor concessions.

Nottingham.—Alderman Brownsword, chairman of the Electric Tramways Committee of the City Council, addressing a meeting of ratepayers, gave some interesting information in reference to the progress of the electric tramway scheme now being carried out in the city. Referring to the Sheerwood-Great Market section, the receipts were steadily increasing, and promised to be extremely satisfactory. The contractors were now occupied upon the construction of the Bulwell-Great Market section (about 5 miles in length), and in the course of a couple of months the whole of the lines would be laid. Next the Great Market-Trent Bridge section (about 2 miles) would be taken in hand, and then the Great Market-St. Ann's Well Road section. Speaking of the recent accident at Liverpool, he said an accident like that could not occur in Nottingham, where the arrangements were much better than in Liverpool. In the latter city large bunches of wires cross and re-cross each other, and the only protection the trolley wire had was provided by *a piece of wood glued on to the top of the wire. In wet weather the glue gave way, and the wood slipped underneath the wire.* In Nottingham the trolley wire was guarded by wires above, and if a telephone wire fell across, there was little probability of it touching the trolley wire.

The words which we have italicised are sufficiently amusing Has the worthy Alderman been the subject of a hoax? We are reminded of Mr. Swinburne's allusions to postage-stamp edging and sealing-wax in the construction of dynamos in the days of old.

Perth.—There is a great probability of the Corporation taking the tramways into their own hands and using electricity as the motive power. Mr. Lambert, the recently appointed resident engineer at the electricity works, took part in the conversion of the Dundee tramways, and his experience will therefore be most valuable to the Corporation.

The work of laying the cables is all but completed, and it is expected that by the end of March the street lamps will be lighted, The plant is at present sufficient to supply 10,000 8-c.p. lamps, and application has already been made for 14,000 lamps. There is already a proposal before the Council to practically double the generating plant. The scheme has been carried out under the personal supervision of Mr. Hawtayne and his partner, Mr. Fairley.

Sunderland.—After waiting a fortnight for the official inspection of two recently completed sections of their electric tramways, the Corporation last week very pardonably lost patience and commenced operations. The traffic was, however, abruptly stopped on the 27th ult. by a peremptory telegram from head-quarters.

Tramway Legislation by Private Bills.—A difficulty has arisen in connection with compliance with the Standing Orders of Parliament in the case of electric tramway Bills. The new traction (says the *Times*) necessitated conditions which were not originally contemplated by the Standing Orders. The Chairman of Committees in the House of Lords therefore proposed to move (on Thursday) certain alterations in the Standing Orders to cover the point. Standing Order 22 at present states that in laying down a tramway "the promoters shall obtain the consent of the local authority of the district or districts through which it is proposed to construct such tramway" and the consent of the road authority. The amendment proposed that where the consents have been withheld it should be for the Committee to consider whether the local authority had acted reasonably, and they should report as to whether or not the consents should be dispensed with. Where such reports were made the local authorities would be entitled to petition and to be heard against the Bill. A further amendment to Standing Order 105 (*d*) will enable a county council alleged to be injuriously affected by a Bill relating to a tramway to petition and be heard against the measure.

Tunbridge Wells.—Two public meetings were held last week for the purpose of discussing the proposal to adopt electric traction in the town and district—one in the afternoon for the "residential" class, the other in the evening for the "working" classes, who are presumably not residential! As might have been predicted, the upper classes opposed the tramways, while the working classes, who would derive the greatest benefit from them, showed a small majority in favour. The "carriage folk" may as well resign themselves to their fate; electric traction is sure to come to Tunbridge Wells some day, and when it does they will use the cars as much as anybody.

Wolverhampton.—In connection with the transition from horse to electric traction, the contract for the first section of the route, which extends for a distance of 4½ miles of road, and about 7½ miles of single track, has been given to Mr. H. Holloway, of Wolverhampton. The contract includes the supply of rails, 1,500 tons, for present requirements. With the exception of the cars, all the work has been allotted to Wolverhampton firms. The contracts let total nearly £80,000 so far.

TELEGRAPH AND TELEPHONE NOTES.

The Cable Communication Committee.—A meeting of this Committee was held on Tuesday at St. Stephen's House, Westminster. Evidence was given by Sir John Wolfe Barry, chairman, and Mr. J. Denison Pender, vice-chairman of the Eastern Telegraph Company, and Mr. Hesse, chairman of the Eastern Extension Telegraph Company.

Cape Town—Dassen Island.—The Cape Town Chamber of Commerce recently dealt with the subject of proposed telegraphic communication between Cape Town and Dassen Island, *vid* Darling and Malmesbury. The scheme had been abandoned; but it now appeared that by means of wireless telegraphy messages could be successfully sent for a distance of 80 miles, and as the distance between Dassen Island and Signal Hill was only 28 miles, it was suggested that communication between those points be effected by that means. It was resolved to make representations to the Post Office Department on the subject.

Eastbourne Telephones.—An expert has been engaged to report on a municipal telephone exchange for the entire Parliamentary division, which includes the towns of Eastbourne, Newhaven and Seaford.

International Telephonic Communication.—Telephonic communication is now available between Paris, Rouen, Havre, Dieppe and Elboeuf, in France, and Berlin and Frankfort-am-Main, in Germany.

Portsmouth.—The T.C. has decided to obtain tenders for the work of establishing a municipal telephone exchange. Mr. Bennett, who was engaged by the Council, estimates that the cost will work out at a rental of £5 17s. 6d. per annum for each subscriber, which is 40 per cent. less than is charged by the N.T.C. The opposing party on the T.C. obtained a statement from Sir William Preece discrediting Mr. Bennett's figures, and alleging that telephones at such a price could only be "cheap and nasty."

Big meetings were also held, and 30,000 reply post-cards were sent out by the opposition party containing a resolution against municipal telephones.

St. Petersburg.—The telephone service of St. Petersburg, which, according to the *Engineer*, for nearly 10 years has been worked by the Bell Company, will on November 1st next be taken over by the State. The new concession is for 18 years. The system at present includes 4,400 subscribers; and the State, with a view to largely extending the service, intends to reduce the annual rental to 55 roubles (£5 18s. 10d.). The present network of wires will be replaced by a new installation capable of serving 34,000 subscribers. The overhead wires will be suppressed and replaced by underground conduits; and public telephone booths will be installed throughout the city. These works are to be finished by 1904.

Telegraphic Interruptions and Repairs:—

Cables.	Interrupted.	Repaired.
African—St. Louis (Senegal)-Bathurst	Aug. 25, 1900 ..	..
South American—Pará-Maranham	March 1, 1900 ..	..
Latakia-Cyprus	June 20, 1899 ..	..
Marseilles-Barcelona	Jan. 7, 1901 ..	..
Aden-Zanzibar	March 1, 1901 ..	..
Landlines:—		
South American—Communication with Carthagena and Baranquilla	Dec. 8, 1900 ..	..
Chinese—Tientsin-Pekin	June 11, 1900 ..	..
Pekin-Kalgan	June 14, 1900 ..	..
Kalgan-Maimatchin	June 30, 1900 ..	..
Tientsin, *via* Shanghai	June 16, 1900 ..	..
Tientsin and Taku *via* Helampo	June 18, 1900 ..	..
All lines connecting Cochin China with Thuanan	Oct. 23, 1900 ..	..
Communication "*via* Hanekine" interrupted on Persian territory	Feb. 26, 1900 ..	..
Moulmein-Bangkok	Feb. 28, 1901 ..	..

Telephone Relays.—Signor Oreste Angelini, ex-Chief of Telegraphs of the Italian Royal Navy, has taken out a patent for a new telephone relay of his invention. In conjunction with Signor Iengo he has been carrying on experiments on the interurban lines of Rome with added resistance, and his results have been most highly satisfactory. During this month an official trial will take place in the presence of the Minister of Posts and Telegraphs and the representatives of several of the great European and American Telephone companies, who are immensely interested in the problem of the telephone relay. Signor Angelini has already received recognition from the Ministry of the Marine for a new system of semaphore signalling and other means of communication between ships at sea.

Wireless Telegraphy.—Orders have been issued directing that wireless telegraphy be installed on His Majesty's battleship *Sans Pareil* before she leaves Sheerness for the cruise of the Reserve Fleet.

CONTRACTS OPEN AND CLOSED.

OPEN.

Aberdeen.—March 15th. The E.L. Committee wants tenders for fuel economiser and Babcock & Wilcox boilers. See "Official Notices" February 15th.

Amsterdam (Holland).—April 1st. The Communal Council will on this date consider tenders for the supply and erection of all the motors necessary, and the installation of the electric lighting of the power station, switchboards, &c. Conditions from the Municipal Printing Office, 10 florins (8s. 4d.). Information from the manager of the office of Electricity, Achterburgwal, 213, Amsterdam.

Ayr.—March 20th. The Corporation wants tenders for boilers, stokers, condenser, pumps, battery, balancer, and booster. See "Official Notices" to-day.

Barnsley.—March 12th. The Union wants tenders for plant, &c., for the electric lighting of the workhouse. See "Official Notices" March 1st.

Bray.—March 14th. The U.D.C. is prepared to receive tenders for Lancashire boiler and accessories, one 150-kw. high speed steam alternator, and one 25-kw. rope-driven alternator and accessories. See "Official Notices" February 15th.

Burnley.—March 23rd. The Tramways Committee wants tenders for overhead equipment for electric tramways. See "Official Notices" March 1st.

Burnley.—March 23rd. The Tramways Committee wants tenders for rail bonds and cables. See two "Official Notices" to-day.

Buxton.—March 12th. The U.D.C. wants tenders for a 250-kw. steam dynamo, and a Belliss engine coupled to two 43-kw. dynamos. See "Official Notices" March 1st.

Buxton.—March 23rd. The Council wants tenders for an electrically-driven triplex pump (17 h.p.). See "Official Notices" to-day.

Cardiff.—March 18th. The Corporation wants tenders for steam, exhaust and other pipes, engine house flooring, switchboard gallery, &c., for electric tramways department. See "Official Notices" February 15th.

Clyde.—March 11th. The Trustees of the Clyde Navigation invite tenders for a 3-ton electric wharf crane for Prince's Dock. See "Official Notices" February 8th.

Colwyn Bay.—March 22nd. The U.D.C. wants tenders for one 120-kw. steam dynamo, and switchboard extensions. See "Official Notices" to-day.

Gorton.—March 22nd. The U.D.C. wants a supply of electricity for its district for lighting, for 5, 7, 9 or 12 years. See "Official Notices" to-day.

Gravesend and Northfleet.—March 25th. The B.E.T. Co., on behalf of the Gravesend and Northfleet Electric Tramways Company, wants tenders for the construction of new tramways and reconstruction of existing lines, and for the supply of electrical equipment. See our "Official Notices" to-day. Last week's advertisement is cancelled.

Hammersmith.—March 13th. The Borough Council wants tenders for twelve months' supply of electrical stores. See "Official Notices" to-day.

Holland.—March 25th. Tenders are being invited until March 25th next by the municipal authorities of Amsterdam, for the equipment of a central electric lighting station in the city.

Launceston (Tasmania).—April 22nd. The Corporation wants tenders for the supply of 500 electric meters. See "Official Notices" January 11th.

Newport.—March 25th. The Corporation wants tenders for steelwork, bunkers, flue, coal conveyer, crane, water-tube boilers, stokers, economiser, tanks, compound condensing vertical engines, electric generators, condensing plant, feed pumps, &c., for electric tramway and power works. See "Official Notices" to-day.

Roumania.—April 3rd. Tenders are again being invited until April 3rd by the municipal authorities of Ploesti, for the construction of an electric tramway in the town and the working of the same during a period of 30 years.

Shipley.—March 19th. The U.D.C. wants tenders for terminal boxes and switchgear, motors, meters, wiring, cables, wires, &c. See "Official Notices" March 1st.

Sunderland.—March 29th. The Corporation wants tenders for india-rubber-covered cables, stoneware casing, wrought-iron piping, and cast-iron piping, box frames and covers. See "Official Notices" March 1st.

Sutton Coldfield.—March 11th. The Corporation wants tenders for house wiring. See "Official Notices" March 1st.

The Hague (Holland).—March 25th. The Communal Council administration wants tenders for the supply and erection of engines and electric plant for the electric lighting of the town.

Wallasey.—March 14th. The U.D.C. wants tenders for electrical tramway cars. See "Official Notices" to-day.

Warrington.—March 27th. The Corporation invites tenders for steel rails and permanent way work; poles, brackets, trolley wire, insulators, &c.; electric tramcars. See "Official Notices" March 1st.

West Ham.—March 22nd. The Council wants tenders for cables, cut-out boxes, wattmeters, transformers, wire and wiring accessories, and engine-room stores. See "Official Notices" to-day.

Wolverhampton.—March 23rd. The Tramways Committee wants tenders for the overhead equipment of 5 miles of route, also feeders, conduits and switch pillars. See "Official Notices" to-day.

CLOSED.

Aberdeen.—The T.C. has accepted the tender of Messrs. Alley & McLellan, of Glasgow, for condensers, at a cost of £1,697.

Bradford.—The contract for two 200-kw. tramway generators for the Bradford Corporation has been awarded to Messrs. D. Bruce Peebles & Co.

Durban.—Among the contracts already placed for the complementary machinery for Durban's electric light service, according to the *British and South African Export Gazette*, are:—For the workshops, 10-ton overhead travelling crane, Messrs. Carrick and Ritchie, Edinburgh, £280. Switch boxes, the Brush Electrical Engineering Co., Ltd., £124. For engine and boiler house, condensing plant, Messrs. Dick, Kerr & Co., Kilmarnock, £2,545; supplementary boiler, Reunert & Lenz, Johannesburg and Durban, £940. For power and light station, steel chimney, Babcock & Wilcox, Ltd., Glasgow, £1,025.

(*Continued on page* 417.)

ELECTRIC CAR BUILDING IN ENGLAND.

There has been so much said of late about lack of enterprise on the part of British manufacturers, that it is refreshing to draw attention to an instance of real thoroughgoing enterprising spirit, venturing a hope that the story of its application, and the success which has hurried after it, may be the means of infusing a little more of that progressive and energetic spirit into some who may be faltering nervously on the verge of wonderful possibilities.

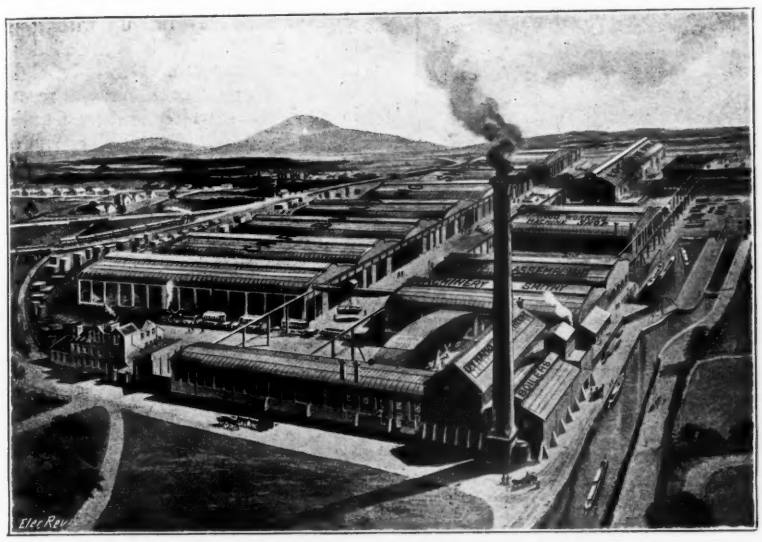


Fig. 1.—Bird's-Eye View.

An opportunity was recently afforded us of spending a few hours in the new car-building works which have been erected at Hadley, in Shropshire, by Messrs. G. F. Milnes & Co., Limited. Under the very genial pilotage of Mr. F. Hughes-Caley, the company's commercial manager, we were enabled to make a tour through the different departments, and to trace, step by step, the many processes through which the materials pass from the landing of the logs, &c., from canal barges at one end of the works, to the turning out of beautifully-finished electric car bodies at the other end.

Our readers are fully aware that Messrs. Milnes have had car-constructing works in operation at Birkenhead for many years past; but with the development which has been occurring in the domain of electric traction, say, during the past five years, it is not surprising that works turning out 400 cars per annum were found to be quite inadequate for the demand that was arising. We are making use of a commonplace, but nevertheless a very true statement, when we remark that the name of Milnes has become a "household word" among all who are in any way whatever associated with tramway development. And that well-earned popularity has led to such an enormous increase in their business, that it became an absolute necessity to erect other works of double the capacity. Thus it came about that land, low in price, and conveniently situated with regard to canal and railway accommodation, and water supply for boiler purposes, was obtained at Hadley, near Wellington.

We can quite conceive that the opening of these works, employing something like 800 men, has aroused the people of Shropshire from their comfortable lackadaisical country ways to greater activity. Enterprise begets enterprise. Certainly it has done so at Hadley. It may be of interest to mention, in view of the approaching completion of other electrical works in this country where large numbers of employés will be required, that not the least difficulty was experienced at Hadley in getting together the 800 men, including ironworkers, mechanics,

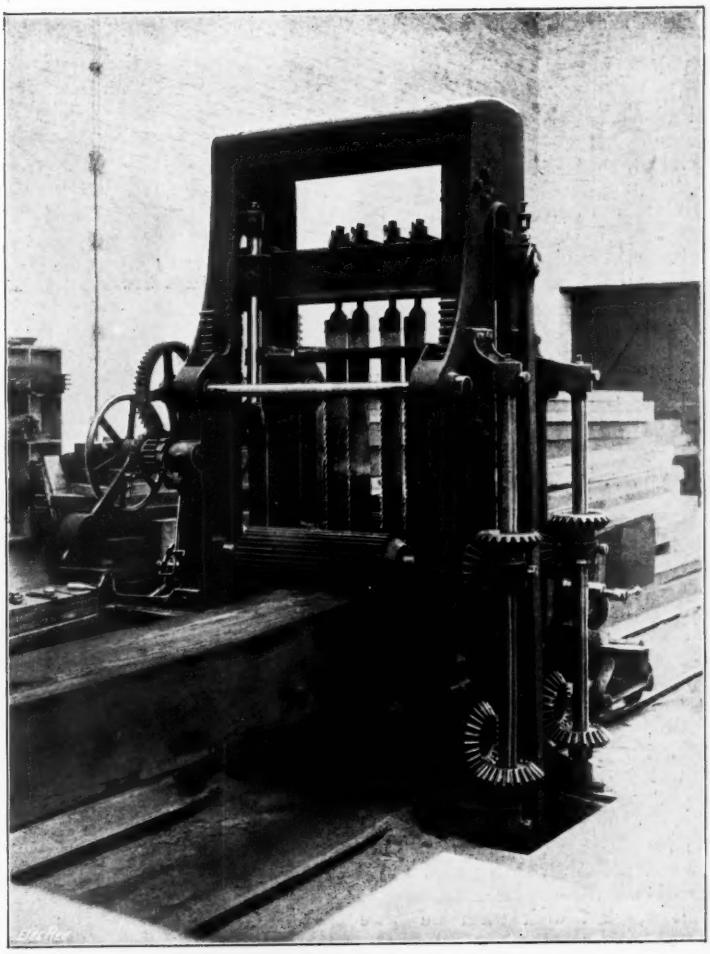


Fig. 2.—Log Saw (Vertical).

Fig. 3.—Basement under Saw Mill.

smiths, carpenters, &c., now at work there. In fact, there were far more applicants than were required, and as the works extend —which they are already about to do — there should be no trouble whatever under the labour heading. Every reasonable attention and consideration has been paid to the welfare of the employés. All the departments are light and airy, and, as well as the proposed provision of a concert hall and club, workmen's cottages are among the up-to-date features of Messrs. Milnes's catalogue of staff attractions.

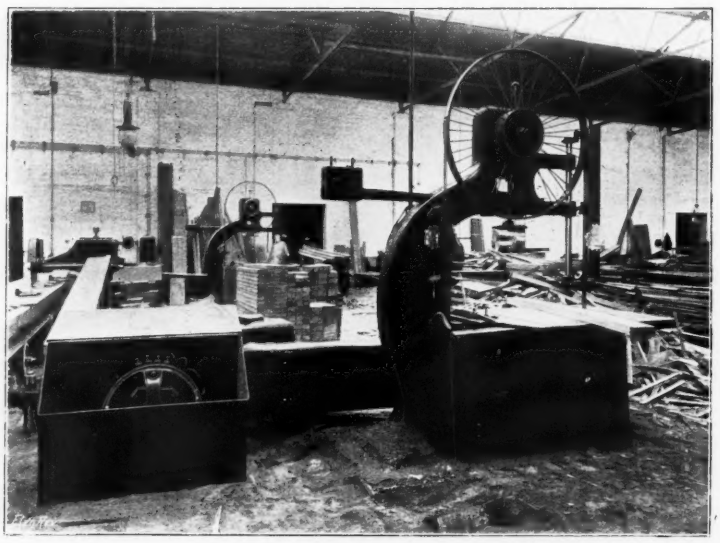


Fig. 4.—Band Saw and Motor.

One great difficulty which has to be faced is due to the inability, we suppose we can hardly say indisposition, of corporations and tramway companies to take delivery as soon as their cars are ready. Considerate corporations will please note! At the time of our visit as many as 90 car bodies were standing completed, or practically so, in the car sheds waiting for dispatch instructions, a condition of things which necessarily gives rise to a good deal of congestion, hampering operations. In view of this fact plans are already prepared, and the contract is being taken in hand, for the erection of a new car storage shed by the side of the present one. This should relieve matters a good deal, at any rate for the present, and car construction will not much longer need to be carried on in the iron assembling room, as it was last week when we were there.

The expenditure upon the works now in operation has already exceeded £100,000, and further sums are shortly to be laid out upon the erection of motor car building works—an additional proof that the firm is not lacking in enterprise. Those electrical manufacturing firms who have hesitated already too long in taking the plunge, and proceeding with extensions to their factories lest the financial risk would not be warranted by the subsequent business, will be interested to learn that the Hadley works are already full up with good paying orders. To be compelled to extend, as they are, after only eight months' working, constitutes a record in car building which finds its parallel in some modern electricity supply undertakings.

The works at Hadley have been laid out on the most up-to-date lines, the designers profiting by experience gained at the Birkenhead establishment and on the Continent. Mr. Carl Busch, who is managing director of the new works, has had a large experience in car construction work on the Continent; and his father, Mr. W. C. F. Busch, has long been known as the founder of a very extensive car-building undertaking there. The machine tools and electrical equipment installed at the Castle Car Works are largely of American and German manufacture, a fact which should be observed by English makers whose eyes have not yet been opened to the fact that the English manufacturer is not getting all the business that might come his way if he were better able to compete with the foreigner.

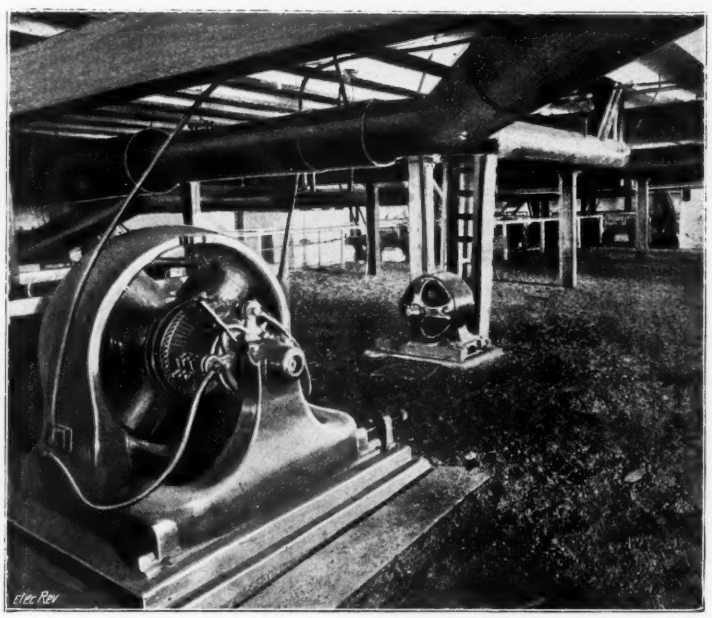


Fig. 5.—Basement under Woodworking Shop.

We understand that it is possible at Hadley to carry

through all the necessary operations from start to finish, and turn out a complete car body, ready for dispatch to the tramway company's depôt for mounting, within about 10 weeks.

A general idea of the arrangement of the works may be obtained from the bird's-eye view which we give in fig. 1. We have lettered the names of the majority of the departments on the roof, so that their relative situations may be taken in at a glance. On the right-hand of this picture will be observed the firm's private dock. It is here that the raw material after arriving at Liverpool in the shape of logs, &c., from America is brought by canal, landed by means of a large crane, and conveyed thence by an electric gantry crane to the log saw mill, where it is duly sawn in a manner to be later explained, and afterwards stored and seasoned. It is necessary to keep a stock of a great variety of timbers on account of the variable climate of Europe rendering a kind which is suitable for one locality quite unsuitable for another. The store contains American ash, whitewood, oak, teak, quartered oak, mahogany, pine, and other descriptions.

This brings us to one of the most important features of the works. The driving power in every department is electrical; sawing machines, wood-working machines, iron-working machines, grindstones, cranes, fans, &c., are all driven either by belt or gearing from a large number of electric motors varying in capacity from 2 H.P. to 50 H.P.

With respect to the operations in the saw mills, the logs having been conveyed here they are, by means of a crane, lifted on to the automatic travelling carriages connected with the saws, and cut economically into various sections such as their cubic capacity most readily suggests. This department is provided with every conceivable kind of saw, and the most recent inventions in machinery incidental to the character of the work done here, such as automatic saw-sharpening and other contrivances for economical and rapid production.

Altogether there are eleven machines in this mill, but a photograph of the whole department would have shown more timber than anything else, and the individuality of the machines would have been lost. We therefore show a couple of the machines separately. In fig. 2 will be seen a log placed in position and partly sawn through by four vertical saws. The electric motor which drives this machine, and several other smaller sawing machines in the vicinity, is situated in the basement. The principal motor here is a 30-H.P. B.T.H., M.P. type, made at Schenectady. It takes 100 amperes, 220 volts at 900 r.p.m., and, as will be seen from fig. 3, is boxed in on account of the great quantity of sawdust which is necessarily present. The motor, by means of a 9 in. leather belt, drives a shaft which in turn operates, by belts and pulleys, the large log saw and several other smaller machines above. In this same basement there is also a 7½ H.P. motor of the same type and manufacture, similarly boxed in. This motor takes 26·5 amperes at 220 volts at 850 r.p.m., and drives a circular sawing machine above. Various other machines in this mill are worked direct from their own separate motors, which stand by their side as shown in fig. 4, where we illustrate one of the two large band saws. The motor, which appears with its case partly open, is a 7½ H.P. of the same type and size as that mentioned above.

Fig. 6.—Wood-working Machine Shop.

Passing down through this department, we came to a log saw machine, somewhat similar to that which stands at the opposite end of the mill (fig. 2), but sawing logs horizontally instead of vertically. This machine, which was operating upon a mahogany log at the time of our visit, is driven by a 10-H.P. motor, taking 34 amperes at 220 volts, 600 r.p.m.

The sawn timber is afterwards taken by trucks to an electric gantry crane, which traverses the main avenue (see fig. 1), and it is then deposited in the timber yard where classification takes place; it is subsequently transferred to the stores to undergo the natural drying process. A period of two years is allowed to elapse before any part of it

is used in car construction. This ensures it being thoroughly well seasoned.

The next step is naturally to the wood-working machine

Fig. 7.—Cabinet Shop.

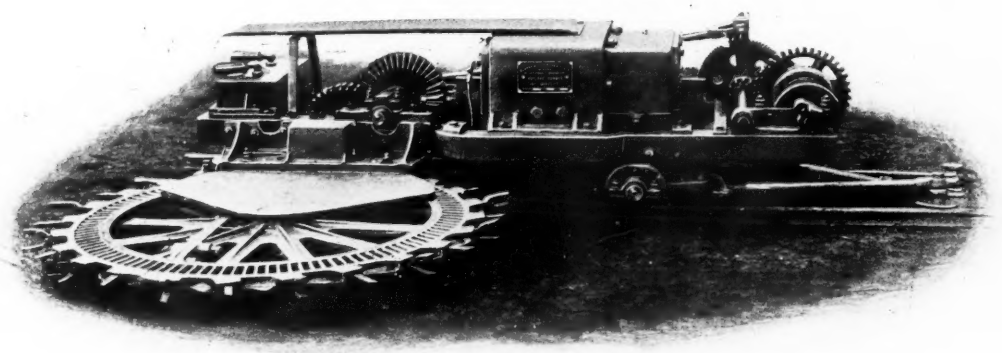
shop, where the wood is transformed into the numerous parts of the car to be built. A photograph giving a general view of this shop appears in fig. 6. There are, as will be seen, a large number and variety of machines. In all there are 36, for shaping, sawing, mortising, planing, moulding, tenoning and ornamental work, all fulfilling their several functions with precision and dispatch. All of the tools were made by the Frankfurter Maschinenfabrik, of Frankfurt-on-Main, and they are all driven from electric motors which are placed in a basement. Each of the larger machines has its independent motor, and for a machine to be started and stopped by merely switching the current is, of course, most economical. Here there are motors as follows:— One 2-h.p., two 7½-h.p., four 10-h.p., two 30-h.p., and one 50-h.p. In our picture of this basement, fig. 5, there will be observed laid under the mill floor a system of main piping. This is for the exhaust system, by which all shavings and sawdust falling from the machines are carried away. This main, which is fed by an exhaust pipe attached to each machine, and furnished with a large fan, which draws all the waste products into the pipe, conveys the contents into a chute, which, in its turn, automatically carries them along to the boiler house, where they are consumed in the furnaces. Not only does this lead to economy in fuel, but it allows the men to work under healthier conditions. The exhaust fan is driven by an electric motor of about 15½ h.p. Although the dust and small pieces of timber are burned as fuel, there are larger, yet useless, pieces which would only block the mains. For these we believe the local Ruths are permitted to come "a-gleaning." They cut quite interesting figures with their filled aprons and loaded barrows.

The wood having been worked up into its varied shapes and sizes, leaves the machine shop for the cabinet shop (fig. 7) all ready for fitting up. In our illustrations the various parts will be observed coming together "bone to his bone," so to speak. Each workman is a master of his own particular branch of work.

(To be continued.)

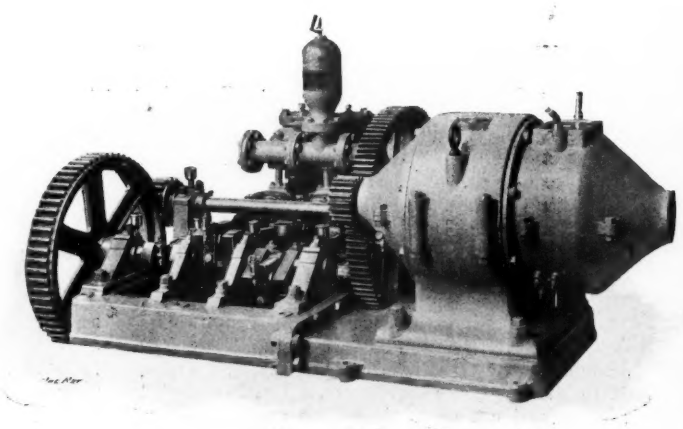
UTILISATION OF ELECTRICAL MACHINERY IN COAL MINES.

In Mr. W. C. Mountain's article which appeared in our issue of February 8th, a wrong illustration was used for fig. 3. The picture which was shown represented a high lift set of two-throw dip pumps. We now illustrate below a set of pumps of the three-throw high lift type, which is direct driven by an electric motor through machine cut spur gearing.



Electrically-Driven Coal Cutting Machine.

Fig. 10 in Mr. Mountain's article represented the special type of enclosed electric motor which Messrs. Scott & Mountain fit on to their coal cutting machines. One of the illustrations now given above shows the actual design of high type machine of this class.



Three-throw High Lift Pump and Motor.

CONTRACTS CLOSED.

(*Continued from page* 412.)

Edinboro'.—The E.L. Committee has recommended the acceptance of the estimate of Messrs. Siemens Brothers & Co., Ltd., for an engine and dynamo for M'Donald Road Station, the amount being £7,434.

Glasgow.—The Brockie-Pell Arc Lamp, Limited, are to supply, at £7 18s. 6d. each, the arc lamps for the centre poles in the Great Western Road from Kelvinbridge to Hyndland; Messrs. M'Dowall, Steven & Co., Limited, Milton Ironworks, supply the canopies and carriers for £7 5s. each.

Halifax.—The Tramways and Electricity Committee of the Corporation has accepted the tender of the Brush Electrical Engineering Company, for the supply of 36 trucks for tramcars at the price of £[illegible]5 each, less a discount of £3 per truck, also the tender of the same company for the supply of 12 tramcar bodies at the price of £238 5s. each.

Southwark. — The E.L. Committee recommended the acceptance of the tender of Messrs. Siemens at £4,310 for the 400-KW. steam generator; that of Messrs. Babcock & Wilcox for two water-tube boilers at £3,230; and that of the General Electric Company for switches, ammeters, and instruments required for the East Street feeder panels on the station switchboard at £117 10s.

Vera Cruz. — Messrs. S. Pearson & Son, says the *Financial Times*, have secured the contract for the conversion of the street railway system at Vera Cruz to electricity. The order, it is said, will work out at about £60,000.

FORTHCOMING EVENTS.

Friday, March 8th.—At 5 p.m. Physical Society. Meeting at the rooms of the Chemical Society, Burlington House.

Saturday, March 9th.—At 3 p.m. Civil and Mechanical Engineers' Society. Visit to Kensington and Notting Hill Electric Light Works.

Monday, March 11th.—At 8 p.m. Society of Arts. Cantor Lectures. I.—"Electric Railways," by Major P. Cardew.

Tuesday, March 12th.—At 7.30 p.m. Institution of Electrical Engineers. Meeting at Owens College, Manchester. Paper by J. S. Raworth on "The Adaptation of the Steam Engine to the Generation of Electrical Energy."

Wednesday, March 13th.—At 8 p.m. Institution of Electrical Engineers (Glasgow Section). Meeting at the Institution of Engineers and Shipbuilders, 207, Bath Street.

At 8 p.m. Society of Arts. "The Proposed High Speed Electrical 'Monorail' between Liverpool and Manchester," by F. B. Behr.

Thursday, March 14th.—At 8 p.m. Institution of Electrical Engineers. Meeting at the Institution of Civil Engineers. If the discussion on Mr. O'Gorman's paper has been concluded at the meeting of March 7th, the following paper will be read: "Some Notes on Polyphase Substation Machinery," by A. C. Eborall, member.

Friday, March 15th.—At 8 p.m. Institution of Mechanical Engineers, Storey's Gate, S.W. "Combined Trolley and Conduit Tramway Systems," by Mr. A. N. Connett, of London.

SYLLABUS—Three methods of mixed electric traction:—trolley and accumulators; trolley and surface contact; trolley and open-slot conduit. General type of conduit. Side-slot and centre-slot construction. Troubles caused by slot-switches with side-slot construction. Mechanical and electrical details to be considered in the construction of a conduit. Insulators—their durability and mode of fastening. Depth of conduit. Switches—precautions against accidents. Special considerations for a "mixed" line. Ploughs constructed with collector-shoes in form of "flappers." Ploughs with shoes pressed outwardly by semi-elliptic springs. Devices for raising, lowering, and allowing lateral movement of the plough. Separate insulated circuit for conduit section in combined trolley and conduit line. Cost of conduits.

Saturday, March 16th. — At 7 p.m. Institution of Junior Engineers' Annual Dinner at the Westminster Palace Hotel.

NOTES.

Water-Tube Boilers in America.—In the annual report of Admiral Melville, engineer-in-chief of the Naval Bureau at Washington, which we recently reviewed, the engineer-in-chief congratulates the United States Navy upon having opposed the innovation in the way it has done. The Naval Bureau, when the advisability of adopting this boiler was urged, submitted the plans to experts, who prophesied the very defects that experience has revealed to ourselves. Admiral Melville takes this opportunity of pointing out "the extreme value of professional criticism in design." It is, perhaps, worth while noticing Admiral Melville's exact words on the subject:—"Some years ago the Department was urged with no little pressure to adopt the Belleville water-tube boiler as a standard for new ships. This Bureau opposed the innovation wholly on a close examination of the designs, criticising the very defective features which, in late years, have made conspicuous the comparative inefficiency of this type, over the purely straight tube, non-screw joint type, for which I have given continuous and urgent preference. The Department is to be congratulated upon escape from this pressure, and upon the conservative approval it has given to the change in the boilers of naval ships." It is the business of the Naval Bureau to examine and criticise very closely all new plans for the improvement of existing apparatus, and such improvements are being continually brought before them by inventors. It naturally calls for very great care in discriminating between what shall be put forward for adoption and what shall be rejected, and considerable responsibility devolves upon the engineer officers whose duty it is to examine and report upon such innovations. The Bureau, in consequence of the hesitancy shown in sanctioning changes, has been accused of being behind the times, and many of the American ships are fitted with cylindrical boilers, in spite of the fact that, though Admiral Melville asserts that he believes water-tube boilers to be wrong in principle, he recognises that the conditions of naval warfare require their adoption. We find that in some cases Thorneycroft water-tube boilers have been substituted for cylindrical boilers at the instigation of the contractors, and it thus seems that the United States has no settled policy in the matter. As regards our own Navy, the Belleville is still on its trial awaiting the decision of the Committee. We understand that extensive observations have been taken for this purpose on board the Cunard Company's ship *Saxonia*. On the whole, we are inclined to agree with *Engineering* that our Navy cannot afford to risk our ships being a little slower than those of other nations. Speed is everything in modern naval warfare, but it is to be regretted that the Belleville boiler has been given such a free hand before its worth was thoroughly tested. We must not be content to watch and wait for other nations to get ahead of us in this respect. The American Navy is not their "first line of defence."

Wireless Telegraphy in the Mediterranean.—It is rumoured in Naval circles that there will be a series of tests given to wireless telegraphy upon a most extensive scale this year in the Mediterranean. Vice-Admiral Fisher, the commander-in-chief, has done much to facilitate the experimental trials of the *Vulcan*, *Tyne*, and those ships which are already supplied with Marconi's apparatus. Several officers have undergone a short course of instruction in order to familiarise them with the instruments with a view, it is believed, of putting them in charge of the apparatus in different ships during the coming cruise. It is said that a line will be formed by all the ships provided with Marconi's telegraphic gear, and that each ship will remain as far from her neighbour as possible without breaking the line of communication. By this means the value of wireless telegraphy in scouting operations will have a splendid trial. To realise what this means if successful, we must imagine a fleet of battleships to be cruising in the vicinity of a certain base. Let us take this base to be Malta, and suppose that of the 50 ships in the Mediterranean squadron, 14 are utilised as telegraphic ships; then if they are stretched out in a line from Malta, and assuming that good signals can be got at 50 miles, the fleet can be in communication with Malta over the arc of a circle whose radius is 700 miles. In other words, the fleet could be ready to enter Gibraltar at a day's notice upon receiving orders to that effect, *viâ* Malta, and to an enemy approaching, there would be no visible connection between Gibraltar and the Mediterranean fleet at all. Admiral Fisher's experiments will be awaited with interest by all who are watching the progress of wireless telegraphy in the Navy.

Electric Light from the Steam Roller.—The following letter, addressed to the *Hull Times* some time ago by a resident of Withernsea, is not without interest. We are growing resigned to the unworthy association of electricity and road sweepings in the hands of municipalities, but we do draw the line at the steam roller and the village pump :—

Sir,—In your last night's issue of the *Daily Mail*, you state that "Mr. Cammidge was evidently a little 'mixed' in his remarks to the Withernsea ratepayers last night, especially when he said it was 'very foolish to spend money on the electric light' when, if they had a steam roller, they could use it to provide the motor power." Now, Sir, Mr. Cammidge made no such statement, and it is quite evident that it was your reporter who was "mixed," as the statement is diametrically opposed to what I did say. The *East Riding Telegraph* in their report gave the exact words used by me, viz., "That Mr. Cammidge was in favour of the electric light, and said the steam roller could be utilised to work the dynamo." I may here explain that prior to my going to the meeting I was in conversation with a gentleman who professes to understand such matters, and he made the suggestion that the engine of the steam roller could be used for this purpose. Unfortunately for myself, when speaking I omitted the words "the engine of."

I shall be glad if you will kindly make the correction in your Monday night's issue of the *Mail*.—I am, Sir, &c.

George Cammidge.

Personal.—Mr. G. S. Ram is resigning his position as electrical engineer to the Coventry Corporation to take up an appointment with the Nernst Electric Light, Limited.

The Wimbledon U.D.C. has raised the salary of Mr. Barnes Spencer from £300 to £400 per annum, in order to retain his services.

Mr. Arthur Jacob having completed the electrical equipment of the Dublin United Tramways Company's system (as resident engineer for the B.T.H. Company), has severed his connection with that company, and has now been appointed acting manager to the Johnson-Lundell Electric Traction Company, Limited, at Soho Square, W.C.

Mr. C. G. Vines has been appointed borough electrical engineer by the unanimous vote of the Kimberley Council, South Africa. There were 21 applications for the post.

Mr. R. Hill, late assistant engineer to the Bromley Electric Light Company, Limited, has been appointed manager of the Harrow Electric Light Company, Limited.

Dr. Julius Juttke has resigned his seat on the board, and his position as managing director, of the Aron Electricity Meter, Limited, after having been connected with the Aron meter for eleven years.

On the occasion of his leaving Aberdeen to take up the post of borough electrical engineer at Rotherham, Mr. Cross recently received a presentation of drawing instruments, scientific books, &c., from the staff of the Aberdeen electricity works.

Mr. Andrew Stewart, A.I.E.E., who has been hon. sec. to the Glasgow Technical College Scientific Society for the past three years, was on Saturday presented with an illuminated address at the eighth annual dinner of the society. Mr. Stewart is leaving Glasgow to become manager and engineer to the Durham Power Distributing Company.

Mr. Marconi has left on a visit to the United States.

Obituary.—We regret to announce that Mr. Evelyn S. Fellows, third son of the Rev. Spencer and Mrs. Fellows, the Rectory, Pulham, St. Mary Magdalene, Norfolk, has succumbed to typhoid fever at Bulawayo. The deceased was Chief Constructor of Telegraphs and Government Inspector to the B.S.A. Co. and electrical adviser to Bulawayo Town Council, having entered the Chartered Company's service some 10 months ago. He was only 29 years of age. The acuteness of the blow to his parents and relatives, to whom we offer our sincere sympathy, was intensified by the fact that no news of his illness had been previously received.

Charges for Electrical Energy.—A Board of Trade conference was held on Wednesday with reference to the Board's proposal that the maximum charge for the electric light shall be reduced from 8d. to 6d. per unit. The reduction was opposed by representatives of various electric lighting authorities, but was supported by the London County Council. Sir C. Boyle said that the Board of Trade would propose a 7d. maximum in normal cases, 6d. in large, populous places, and 8d. in special cases where cause could be shown for such a maximum.

Obsolete Methods in Mathematics.—Speaking at Birmingham on the 27th ult. at the inauguration of the local section of the Institution of Electrical Engineers (which we shall report more fully in our next issue), Dr. Oliver Lodge, principal of Birmingham University, said that some people seemed to hold that general education and mathematics were unpractical and useless encumbrances. The objection arose from a suspicion that mathematics were often so badly taught that by the time a man had acquired a great deal of it he was somewhat unfitted for anything else. If that was so, it was a grievous fault, and he knew that the fault did exist. The training of a pure mathematician was one thing, the training of engineers and physicists was another. The reform of mathematical teaching had been taken in hand by several, but the old mathematical Tory perseveringly conducted the patient English youth by roundabout paths, the continued use of which was a monument of modern folly. Euclid's work was admirable, but, like some other good things, it was out of date. We were too busy and there was too much to learn nowadays to leave time for us to cross every river by ascending to its source and walking down the other side. The bridges were there, and sooner or later even schoolboys would be permitted to make use of them and enjoy the country on the other side without spending all their days in the toilsome and deterrent mode of getting there over the route approved of by the ancients.

It is only too true that, even in some of our technical colleges, a system of teaching mathematics is in use which is infinitely more likely to create an intense aversion from the subject in the mind of the student engineer, than to reveal to him its immense importance as the engineer's handiest everyday tool. This is one of the most crying evils in our technical educational system. Mathematics should be taught to engineers *by engineers*, and not by mathematical enthusiasts who lose sight of the end in their admiration of the means.

Institution of Electrical Engineers (Cape Town).—The opening meeting of the third session of the Cape Town Section was held before the departure of the last mail to hand, in the Railway Electric Light Works. The annual report stated that the membership of the parent institution resident in the Cape Peninsula had increased from 25 to 32 during the session. The meetings had been of a uniformly interesting character, 14 papers having been presented and discussed on various subjects connected with the science of electrical engineering. The election by ballot of officers for the coming session then took place, when the following gentlemen were elected :—Chairman, Mr. C. Proctor Banham, M.I.E.E., mechanical and electrical engineer to the Table Bay Harbour Works ; vice-chairman, Mr. John Denham, M.I.E.E., electrician to the Cape Government Railways ; secretary, Mr. W. J. Howe, South African College ; member of committee, Mr. F. Pickering. Before the meeting broke up Mr. Denham showed some samples of the latest form of Nernst lamp ; unfortunately, all had been broken in transit, so it was impossible to give them a practical test.

To Central Station Superintendents.—The New York *Electrical Review* is offering a prize of $100 for the best article upon the electric lighting central station superintendent—his duties, how he may best fit himself for them, what steps he must take to ensure success in that profession, and what type of man is best fitted by character, experience, education, and brain texture for employment under conditions of great responsibility by owners of such installations. The length of the article is to be 3,000 to 5,000 words, and May 1st is the latest date for sending in.

Improving the Press.—We suppose that no two electrical scientists have juster grounds for grievance against the sensational press than have Edison and Tesla. The *Electrical World* remarks that the Correspondents Club of New York recently invited opinions as to increasing the good influence of the Press, and received the following among others :—Thomas A. Edison—"By publishing a fact now and then." Nikola Tesla—"The influence of the Press might be greatly increased by adopting a better system of informing the world of technical and scientific advances."

The Question of Electric Lighting Competition: Company v. Council.—Readers who are interested in the question of electric lighting competition, and in the problem of municipal trading, would do well to study the report of the Metropolitan Electric Supply Company in our "City Notes" columns. The ups and downs of the negotiations between the Marylebone Vestry and the company were very clearly explained by Mr. Harrison Cripps. It seems a crying shame that a local authority (without a body to be kicked or a soul, &c.) should be able to harass a company which is legitimately engaged in the development of business, for no other reason than that it wants to obtain control of the company's undertaking at an unreasonably low figure. There would be more fairness in permitting a private company to compete with a neglectful Corporation; but for a Council which has express supervisionary powers to be allowed to compete with an existing company which is deficient in regard to these "prying" powers, and is to a great extent under the Council's control, would be absolutely unjust, and, as Mr. Cripps says, is hardly to be conceived. It is one of the thousand-and-one points which must necessarily arise when the problematical question of municipal trading is properly considered. The Borough Council of Marylebone may be pretty sure of most stern opposition, for the principle of the thing is too important to be lightly regarded. Perhaps it might be better advised if it agreed with its adversary quickly.

Lectures.—At a meeting of the East of Scotland Engineering Association last week, with the hon. president, Mr. W. A. Carter, C.E., in the chair, a lecture was delivered by Mr. R. W. Hogarth on "Electricity as a Motive Power for Railways." The lecturer gave in his introductory remarks some interesting figures relative to progress in Great Britain and Ireland. At the end of 1900 some 52 electrical tramways and light railways were in operation, representing about 600 miles of route, while 25 undertakings with over 300 miles of route were authorised or under construction. About 14½ route miles of electrical railways were in operation in London, with other 19 miles under construction, and an additional 21 miles authorised. The capital invested by British electric traction companies had risen from 8½ millions sterling in 1897 to 19½ millions in 1899, and over 26 millions in 1900. Eleven municipalities had in 1899 expended some £1,170,000, and this increased in 1900 to 18 municipalities, with an expenditure of some £2,750,000; thus the expenditure more than doubled itself within 12 months' time. The multiple unit system must necessarily displace the locomotive for passenger lines at least. For railway work the overhead trolley line would be as far as practicable superseded by the third rail fixed alongside the track rails. The lecturer was awarded a very hearty vote of thanks.

Prof. Sidney H. Short delivered a lecture on "Tramway Motors," at the Liverpool Royal Institution last week, before the members of the Liverpool Engineering Society.

A Popular Electrical Journal.—This year a new electrical monthly paper, *Elektrotechnische Mitteilungen*, has been started in Germany. The object of this journal is to supply information about electrical progress to persons who are interested in the subject, but are not themselves technically-trained electricians. There are many persons belonging to this class; for example, proprietors of electrical installations, railway and post office officials, architects, civil and mechanical engineers, chemists, teachers in high schools, &c., and the journal ought to have a wide circulation. The first number contains popular articles on the replacing of accumulator traction by the trolley system on the Berlin tramways, the change being unfavourably criticised, on the question: "What is Electricity?" the conclusion being that electricity is an ether stream; electric meters; how to make a galvanic element; electric glow lamps; and so on. The articles are clearly written in a style well suited for the class of persons for which they are intended. We wish our new contemporary the success it deserves.

Electrocutions.—An American exchange learns that the Indiana Senate has resolved to adopt electrical means for inflicting capital punishment in that State.

Appointments Vacant.—A clerk of works is required for the Heywood electricity works. An assistant electrical engineer is wanted for Ilford at £120 per annum. A "works manager," at £350 per annum, is wanted for Coventry. A chief assistant, at £120 per annum, is wanted for Leith. The London Electric Supply Corporation wants an assistant engineer, at £150 per annum, for Deptford. See "Official Notices" to-day.

Accrington Electricity Works.—The formal opening of the Corporation electricity works took place on Monday. The works had been running temporarily since last November.

Electrical Exhibition.—An electrical exhibition is to be held at West Ham during the week ending May 25th, and electrical firms are invited to exhibit. See "Official Notices."

NEW COMPANIES REGISTERED.

British Electrical Manufacturing Company, Limited (69,471).—This company was registered on February 28th, with a capital of £10,000 in £1 shares, to acquire and carry on the business of electrical engineers and manufacturers now or lately carried on by J. D. F. Andrews & Co., Limited, at Fulham, to adopt an agreement with D. R. Broadbent, and to carry on the business of electric light contractors, electricians, engineers, suppliers of electricity for all purposes, &c. The first subscribers are:—D. R. Broadbent, 14, Grenville Street, W.C., electrical engineer, with 250 shares; N. Knowles, 3, Park Mansions, Howard's Lane, Putney, S.W., electrical engineer, with 250 shares; E. F. G. Oxley, 48, Pembridge Road, Bayswater, solicitor; F. W. Cobham, 74, Hollydale Road, Peckham, clerk; H. G. Clark, 53, Oaklands Road, Hanwell, clerk; T. P. Baines, 47, Boswell Road, Thornton Heath, clerk; and C. Lewis, 31, New Street, St. John's Wood, N.W., clerk. The five last named hold one share each. No initial public issue. The number of directors is not to be less than two nor more than five; the subscribers are to appoint the first; qualification, £250; remuneration as fixed by the company. Registered office, 37, Walbrook, E.C.

H. Ingram, Limited (69,450).—This company was registered on February 25th, with a capital of £2,000 in £1 shares, to acquire the business of an electrical engineer and contractor now carried on by H. Ingram at 72A, Sankey Street, Warrington, under the style or firm of "H. Ingram & Co.," and to carry on the business of electricians, electrical engineers, mechanicians, manufacturers of and dealers in electrical plant, engines, vehicles, fittings and apparatus, &c. The first subscribers (each with one share) are:—Henry Ingram, 37, Liverpool Road, Warrington, electrical engineer; William Bibby, 2, Thynne Street, Warrington, assurance superintendent; Robert Lees, 200, Knutsford Road, Warrington, gas meter inspector; Alfred W. Howard, 94, Bewsey Road, Warrington, accountant; Harry Bibby, 2, Thynne Street, Warrington, electrician; John R. Evans, The Willows, Great Sankey, near Warrington, solicitor; and Thomas E. Knowles, 24, Lovely Lane, Warrington, solicitor's clerk. No initial public issue. The number of directors is not to be less than three nor more than nine; the first are to be appointed by the subscribers; qualification, £25.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Adams Randall Telephone Patents Company, Limited (61,457).—This company's annual return was filed on January 2nd, when 50,000 ordinary and 400 preference shares were taken up out of a nominal capital of £60,000 in 50,000 ordinary and 10,000 preference shares of £1 each. £1 has been called up on each of 7 ordinary and 400 preference shares, resulting in the receipt of £407. £49,993 considered as paid on the remaining ordinary shares.

Electric Railway, Tramway and Carriage Works Company, Limited (57,082).—This company's annual return (dated October 17th, 1900) was filed on January 19th, when the entire capital of £150,000 in 30,000 shares of £5 each had been taken up and paid in full. No mortgages or charges.

Accumulator Industries, Limited (67,180).—This company's annual return was filed on January 17th, when 5,584 shares were taken up out of a nominal capital of £10,000 in £1 shares. £1 per share has been called up on 584 shares, resulting in the receipt of £584. The remaining 5,000 shares are considered as fully paid. No mortgages or charges.

SUPPLY STATION ACCOUNTS.

St. Helens Corporation Electricity Accounts.

The accounts we now summarise of the St. Helens Corporation electricity supply undertaking cover the early stages of a comparatively recently opened works, and as the second of the two years given includes traction supply, whereas the first does not, the figures are naturally very different. The addition of a traction load has led to a change in the system of supply from alternating, as originally designed by the consulting engineer, to direct current. Mr. J. S. Highfield is now acting as engineer for extensions as well as engineer in charge of the works. The change-over, and traction equipment take up much of the extra capital. Traction plant absorbed £17,300, and the line equipment £15,946.

General Statement.

	1898.	1899.	Increase.
Total capital expenditure ...	£21,770	£69,157	£47,387
Number of units sold	65,091	320,106	255,015
No. of 30-watt lamps connected...	6,463	13,981	7,518
Maximum load in KW.	108	410	302
Gross revenue	£1,559	£5,044	£3,485
Gross expenditure	£1,217	£3,131	£1,914
Gross profit	£342	£1,913	£1,571
Average price per unit sold ...	5·61d.	3·61d.	−2·00d.

The reduction in receipts per unit sold is explained by the fact that whereas the rates in 1898 were, for private lighting 6d., and power 3d. per unit, during 1899 a reduction brought these down to 4½d. and 2d. respectively. The capacity of plant installed in these two years was 145 KW. and 750 KW. The output was distributed thus:—

Year.	Private consumers.	Street lamps.	No. of street lamps.	Traction sales.
1898	60,296	4,795	4	—
1899	112,920	25,110	35	182,076

The tramways are operated by the New St. Helens Tramway Company, to whom the traction energy is sold. In the latter year an appreciable sum was derived from the hiring and fittings department, which did not exist in 1898.

Revenue Statement.

	1898. Gross.	1898. Per unit.	1899. Gross.	1899. Per unit.	Increase.
Sale of energy	£1,522	5·61d.	£4,814	3·61d.	−2·00d.
Meter rents	37	·14d.	54	·04d.	−·10d.
Sale of fittings, hire of motors, &c.	—	—	176	·13d.	+·13d.
Sundry	—	—	—	—	—
Gross revenue ...	£1,559	5·75d.	£5,044	3·78d.	−1·97d.

In the costs, the first two items are particularly low, and the improved load factor has enabled coal to show an improvement of $\frac{1}{10}$d. on the previously satisfactory figure of ½d. Wages were naturally high, with a small output, but all the other items were quite passable, while this has now been reduced to ¾d., in keeping with similar stations of moderate size. The total cost would be nearly ½d. better than is shown were it not for the inclusion of a special charge, taken in the published accounts as of the nature of repairs, for "changing from alternate to direct current supply," amounting to £301.

Cost of Production.

	1898. Gross.	1898. Per unit.	1899. Gross.	1899. Per unit.	Increase.
Coal	£163	·60d.	£668	·50d.	−·10d.
Oil, waste, water and engine room stores	30	·11d.	54	·04d.	−·07d.
Salaries and wages incurred in generation and distribution	557	2·06d.	795	·60d.	−1·46d.
Repairs and maintenance buildings, boilers, engines, dynamos, &c., overhead equipment and street lamps	128	·47d.	323	·24d.	−·23d.
Works cost ...	£878	3·24d.	£1,840	1·38d.	−1·86d.
Rent, rates and taxes ..	153	·56d.	321	·24d.	−·32d.
Management expenses, salaries of managing engineer, secretary, clerks, &c.	103	·38d.	271	·20d.	−·18d.
General establishment charges, stationery and printing, law charges and insurance	83	·31d.	398	·30d.	−·01d.
Other expenses: Changing from alternating to direct supply.	—	—	301	·23d.	+·23d.
Total costs ...	£1,217	4·49d.	£3,131	2·35d.	−2·14d.

The profit statement shows an increase of over £1,200 in the financial charges, but notwithstanding this, as the gross profit rose by nearly £1,600, the net loss of 1898 has been converted into a net profit of £13. As the corner has been turned, and the business is covering all expenses, the figures for the year now closing ought to be altogether satisfactory, save, perhaps, that coal may show an upward tendency.

Profit Statement.

	1898.	1899.
Interest on loans, overdraft and deposits	£417	£939
Sinking fund for repayments	264	961
Net profit carried to superannuation fund	—	2
„ „ forward	−339	11
Gross profit	£342	£1,913

CITY NOTES.

Metropolitan Electric Supply Company, Limited.

The annual meeting of this company was held on Tuesday at Winchester House, Mr. W. Harrison Cripps presiding.

In moving the adoption of the report, which appeared in our last issue, the Chairman said that during the year their capital expenditure had increased by £173,000, from £1,244,254 to £1,417,000. That money was chiefly expended upon two operations. A considerable amount had been spent at Willesden developing the machinery and general plant; the remainder had been expended upon the alteration of the system from alternating to continuous current. They decided upon the change some two or three years ago on the ground that continuous current working was very much more economical than intermittent current. The change had now been nearly completed in the mid-London area, and they were at present laying down cables in the South portion of their West London or Marylebone area. They had had great hopes of that portion being completed so as to supply current for next winter, but there was so much delay in obtaining the necessary consents for extending Mauchester Square station, that he was afraid it would be impracticable to work those mains in the forthcoming winter, although they would be ready soon thereafter. They had bought a freehold house in Stratford Place for new offices. They had issued the remaining £125,000 3½ per cent. debentures at £96 per £100, and to-day they stand in the market at 98 to 99, which showed that the credit of the company was exceptionally good. They had also issued at par the remaining portion of the shares—£150,000. The gross revenue for the year was £209,420, an increase of £30,000. The cost of generating was £106,000—an increase of £15,000. The increased cost was largely due to the cost of coal, which, especially towards the latter half of the year, rose very largely. Fortunately, they had, at that time, made very short contracts, which they were able to renew at the beginning of this year for a short period at better terms than if they had taken a long contract, and there seemed to be every prospect that they would be able to renew at even more favourable terms for the remaining portion of this year. The repairs came to rather a large amount. This was chiefly because of the way they were bound to use their stations in the year 1899. They were then finding it difficult to supply a sufficient amount of electricity, and all the stations had to be worked at high pressure, with the consequence that a good deal of damage was done to the chimney shaft, boilers, and so on. They had all been put in order now. In 1899 £2,000 was spent in buying current, but for 1900 this item was about £20. They had now a large amount of superfluous machinery sufficient to supply any current they were likely to require at present. Law costs for 1889 were £1,900, but for 1900 only £170. The Rucker action was decided in favour of the companies. What was exceptional about this affair was that they actually got some of their law costs returned by the other side. They had set aside £14,000 for depreciation. That, after careful consideration two years ago with the auditors and advisers, they found to be the sum, which being gradually increased year by year would give them a very substantial and efficient reserve, for what they would want at the end of their concession. Practically they had already had £100,000 for reserve. £20,000 of this had been written off, and at the present time they had £78,000 invested in first-class outside securities. It was thus an available asset which could be realised at any time. They had added 70,000 new lamps during the year. The weekly application showed there to be no falling off in the number. Referring to Willesden, they had at the present moment three of the Westinghouse engines working, and another two of the same capacity were in course of erection. These would be completed by the middle of the summer. Then at Willesden alone they would have a capacity of 12,500 H.P., sufficient to supply about half a million of lamps connected. In regard to the negotiations with the Marylebone Borough Council, the chairman made the following interesting remarks:—"I must not neglect this opportunity of drawing your attention to what these negotiations are, and what our relationship is with this Council. I may remind you that in 1882 and 1888, the two years of the Electric Lighting Acts, the vestries were given the first choice of whether they would undertake the supply. At this time, although electric lighting was an engineering success, it had not been proved that it was a commercial success in London. The Marylebone Vestry having considered the matter thoroughly, were afraid to undertake the risk. They encouraged this company to come in. We got our Bill with their sanction, and also with a special agreement which they made with us, which gave them certain more favourable terms than the ordinary terms of the Electric Lighting Act. When we first started we had to do a great deal of pioneer work, with the result that after some years working we were still paying no dividend. Then worse than that; we had an injunction against us

for a nuisance arising from our engines, and it was only with the greatest difficulty that we got over that crisis. It meant renewing a considerable part of our machinery, and in order to do that, we had to raise more capital, and not at that time under very advantageous conditions. In 1896, 1897 and 1898 we began to pay a dividend, that dividend rising to 5 per cent; then in 1898, the Marylebone Vestry having held their hand all the time we were in difficulties, until we were making a profit, then thought it was the time for application to Parliament for powers to compete with us. They applied and brought evidence, and their Bill was thrown out. But not satisfied with this, the following year they brought in a second Bill to compete with us. That shared the same fate. After that they thought they would negotiate with us to see if they could buy our concern at some cheap rate. Negotiations came to nothing at that time, but they were renewed last autumn. The directors appointed a small committee, and the Vestry did the same, and after several conferences, we eventually came to what I believe was a fair and just provisional agreement to sell the Marylebone portion of our undertaking to the then Marylebone Vestry. The agreement was subject to the sanction of the shareholders and the sanction of the Vestry. The agreement was subject to the figures that we brought before the Vestry, being verified by an independent accountant appointed by them. The provisional agreement came before the Vestry on August 3rd, and was passed by a very large majority, but a month later, when the minutes had to be confirmed, the Vestry changed their minds, or rather were influenced, and they refused, by a small majority, to confirm those minutes agreeing to the purchase, with the result that the agreement fell through. We have tried our best to work amicably with the local authority, and we have tried our best to come to terms, but have not succeeded. I can only say that the directors intend to oppose the most strenuous opposition they can to throw out this Bill that the Vestry have in Parliament this year. On the question of rate-aided trading, I am confident it never could have been thought possible when the Electric Lighting Acts were contemplated and passed that we should have a trade rival in the Vestry. The powers of supervision given to the Vestry by Parliament and required by agreement are very stringent. They have powers which they use, and we should not mind those powers if they were being exercised by independent authority; but they are exercised by the Vestry, that is unfair. They watch us in the most jealous way. We have our chimney stacks constantly observed. We have our voltage tested. We have our mains examined. Not only that, they have a special electrical specialist, who is empowered to come into our works at any time, which he constantly does. He sees any of our new devices, our experiments, and, in fact, prys into what ought to be our trade secrets. If the Vestry has the power to supply in competition with us, what is to prevent this knowledge which he acquires being used for the benefit of our rivals? Undoubtedly it will be so used. According to our Act, we are bound to give notice to the Vestry. We cannot lay a new main, cannot connect a single customer, without giving a notice to the Vestry, who have the right to withhold their consent. When they become trade rivals to us they will have the knowledge and the time, and will say, when a certain customer wants to be connected, 'Why do you wait a month to be connected to the M.E.S. Company? We will connect you to-morrow!' They have the means of knowing all our customers. We do not fear competition. . . . . If we are to have competition, let it be a fair and open competition. Let it be with other companies who are under the same obligations as ourselves as to notice which they have to give, as to time of concession, restrictions, and so on. But this is not competition that we are threatened with. We are threatened with competition with the Borough Council, clothed with its extensive powers of supervision given by Parliament. That is not competition; it is confiscation. I never can believe for a moment that a Parliamentary Committee would sanction such a scheme, inflicting as it would a blow upon the free and independent trading which I believe to be the life and soul of the commercial enterprise of this country."

The adoption of the report and declaration of dividends was seconded by Sir James Pender, and carried with acclamation.

The retiring directors and auditors having been re-elected, the meeting became special, and confirmed resolutions already passed regarding the powers which are being sought to lay a duplicate main from Willesden. The main will take a different route to the existing cable, and will pass down Harrow Road.

A cordial vote of thanks closed the meeting.

Charing Cross and Strand Electricity Supply Corporation.

The annual general meeting of this company was held on Friday of last week at St. Martin's Town Hall, Mr. J. M. Gatti in the chair.

In proposing the adoption of the report, the Chairman said he was pleased to be able to congratulate the shareholders on the position of the corporation, and said that the demand for current had shown a steady increase during the period under review. In their old district of St. Martin's-in-the-Fields, nearly 14,000 additional lamps had been connected, and in the Strand district, between 15,000 and 16,000 more lamps had been supplied, and in the districts of Holborn and St. Giles's, only a small portion of which came within their powers, a further 7,000 lamps. Just lately a new demand had been coming forward for motor and heating apparatus, and in the course of the past 12 months, the company had doubled their supply under those heads, and now that they were laying down mains in Fleet Street, the great printing centre of London, they found the applications for the power decidedly satisfactory. The board had been asked to follow the example of the gas companies and hire out motors and heating apparatus to consumers, and he thought it would be a good policy to do so. Turning to the gross revenue for the year, they found it was in a most satisfactory state, there being an increase of nearly £16,000, an increase which was half as large again as that shown last year over the preceding year, and it would give them an idea of the rate the business of the company had gone on, when he told them their gross revenue was double what it was three years ago, in 1897. In view of this fact he could very well understand the shareholders inquiring how it was, and the accounts did not exhibit a better net result, and why they proposed to pay only the same dividend as last year, and that, in order to do even that, they had to fall back upon some of the carried forward of the previous 12 months. There were two causes for this, both of which were beyond the control of the directors. The first was the rise in the price of coal which had made a difference to their net revenue of between £7,000 and £8,000. The second cause was the serious fire which broke out last March at their station in Maiden Lane. He was not referring to the loss of capital resulting therefrom, and which when fully ascertained would be provided for out of the premium reserve fund, but to the extremely uneconomical manner in which the business had to be carried on for a considerable length of time. The chief steam generating station at Lambeth was now for all practical purposes fully equipped. At Short's Garden there were 1,500 kw. in motor-generators and 400 kw. in batteries. But for the fact that the Short's Garden station was just completed at the time when the fire at Maiden Lane occurred, he hardly dared think what the company would have done. The Maiden Lane station was, as had now been the case for some years, doing all that it really could do. Owing to the increase of business in the district of St. Martin's-in-Fields and in the western district generally, it was imperative to have a new station in the neighbourhood, and a site had been acquired in St. Martin's Lane for that purpose, and also to erect on the site new offices for the company for the accommodation of their staff, as they were always increasing the staff. At Ludgate Hill station the company had commenced to supply current, the plant there consisting of 600 kw., capable of supplying 30,000 lamps. Their Fenchurch Street station was being rapidly constructed, and it was hoped to be finished by the end of next year, and their Bow station was also being pushed along. He would mention that the company were now supplying current to 166 streets in the Western area and to 55 streets in the City area. He thought the business could not be described as anything else but extremely satisfactory, and if the shareholders continued to repose in the directors the same amount of confidence that they had hitherto done, no pains would be spared by the board to further increase its successful career.

Mr. G. H. Glasier seconded the motion.

Mr. Laurie said he thought, taking into consideration the high price for coal which the company had had to pay last year and the difficulties which they had been working under, the result was very satisfactory. He would like to know in regard to the high price of coal whether the company had been able to make a satisfactory contract for the present year.

Mr. Nevill said he noticed in the accounts the sum of £1,377 for interest on temporary loans. Did he gather from that that the company had not sufficient working capital and were obliged to resort to banks in order to keep the business going.

Mr. Makins asked if it were possible for the company to recoup themselves for the loss by the fire in Maiden Lane by insurance or otherwise.

The Chairman, replying, said respecting the question of coal, he might say the company had secured a contract for Welsh coal at a rate which although not favourable as compared with the price paid 18 months ago, was still a considerable improvement on what they had been paying during the last 12 months, and they hoped next year to come before them with a saving of about £4,000 on their coal account. Regarding the question of temporary loans, it was because the old debentures had had to be paid off, and the company had had to borrow money. It was true they had no money in their capital account, for their works had absorbed all their capital, and, therefore, the company would have to shortly issue further capital. In reference to the question of insurance, their station in Maiden Lane was insured, and they recovered most of the money on most of the things, but they lost a large sum of money on their switchboard, which they had not insured.

The report was adopted.

On the motion of the Chairman, seconded by Mr. J. H. Glasier, a dividend at the rate of 9 per cent. per annum was declared.

Chelsea Electricity Supply Company.

The ordinary general meeting was held on Wednesday at the Town Hall, Chelsea, S.W., Mr. J. Irving Courtenay presiding.

The Chairman, in proposing the adoption of the report, said that the dividend recommended on the ordinary shares was at the rate of 5½ per cent., being half per cent. lower than had been paid for some years past. That might have been anticipated by the shareholders in view of the high price of coal, but notwithstanding the fact that they paid £1,800 more for coal, that circumstance alone would not have lowered the dividend. There had been three causes operating together to bring about a reduction in the dividend—the increase in the price of coal, the diminution in the amount

of revenue per unit sold resulting from the reduction in price to consumers who took the supply at 200 volts (a decrease amounting to ½d. per unit on the whole supply, or close upon £3,000), and the unusually light weather in the first and last quarters of the year 1900, which they estimated to have diminished the revenue by much more that a £1,000. The reduction of price introduced with the "maximum demand" system of charging has been gradual in its effect, as it came into force only when a consumer took the supply at 200 volts, their original supply having been at 100 volts, and, although the system had been in use for little over a year it had already resulted in bringing on a number of small but regular consumers, whose consumption would be really more remunerative—at a low price, than was that of the more wealthy consumer at the higher price, he meant the consumer who used the light regularly for long hours and was practically always in town, such as the smaller householders and tradesmen. A further reason for their belief in the success of the system lay in the fact that in this short time there was an increase in the units sold per lamp, only of half a unit it was true, though that amounted to something on nearly 150,000 lamps, and that foreshadowed a more substantial increase in the future, as the advantages of the system became better known. The reduction in price was absolutely necessary in order to develop their business and compete seriously with gas. In that connection he might mention that a large proportion of their customers being now supplied at 200 volts it had been found unremunerative to continue to supply others at 100 volts, as the distribution at that pressure was more wasteful, and they had to keep special machinery going for the purpose. They had therefore felt obliged to give notice of their intention to raise the price for the 100-volt supply to 7d., and he felt sure that those customers would see it was their interest also to speedily adopt the higher pressure as many had already done. The cost of production had remained about the same, with the exception of the increase in the cost of coal alluded to, and some slight reductions in the cost per unit under other heads. The number of lamps added during the year was 16,410, which was about the same number as were added during the previous year (16,280), and the number of customers connected on was 371. That compared with an addition of 274 during the previous year. The fact that in order to obtain the same total number of additional lamps it was necessary to connect on a larger number of customers, was in a way a good sign, as it indicated the bringing in of a more remunerative class of customer. He hoped everything would be done to increase that class of customer. They were bringing under the notice of the consumers the extension the company had made, and particularly the low average of the number of units consumed per lamp, which should increase greatly the business of the company. The capital expenditure was nearly £22,000 less than that of 1899. A similar amount to last year, viz., £3,000, had been added to the renewals and depreciation fund out of the net revenue, and the amount received on account of premium up to December last on the new issue of shares had, after some deductions, been carried as before to the reserve fund. He would remind them that in 1898 they obtained an Act of Parliament giving the Chelsea Company powers to purchase compulsorily certain lands and properties for the purposes of its business. Those purchases had to be made within three years from the passing of the Act, and their powers expired this summer. They would therefore have to invest a substantial sum before the end of the year in acquiring those properties, which they estimated would give them sufficient space for all buildings necessary for the supply of current to the whole of the borough of Chelsea. In becoming the landlords of the property, they would be receiving some return on the money spent before they required to use the land for the extension of their generating stations.

Major-Gen. Webber, in seconding the motion, remarked upon the difficulties and risks which electric lighting companies had to encounter nowadays—risks and difficulties which were not anticipated at the time they obtained their provisional orders. Under all the circumstances, he thought the shareholders should look upon the results obtained last year as very satisfactory, and he could assure them that those results had only been achieved by careful management. It was a matter of satisfaction that their relations with the local authorities had always been of the pleasantest character.

After some discussion the report was adopted.

Subsequently an extraordinary general meeting was held, at which resolutions were passed altering certain of the articles of association, in which, *inter alia*, the directors took power to pay commission, in connection with the issue of any fresh capital, to such persons as they might think fit.

Northampton Electric Light Company.

The annual meeting of the shareholders of this company was held on Thursday last week. Mr. F. H. Thornton, the chairman, presided, and, in moving the adoption of the report and balance-sheet, which have already been given in these columns, said that the year had been one of considerable progress. During the year 5,696 lamps had been put on, and the number of motors had been increased from 14 to 18, while 15,000 units for motor power had been used as against 5,700. During the year a new engine room had been built, and two new engines had been put in in order to enable them to cope with the increased demands upon their resources. After some discussion the report was adopted. The retiring directors, Messrs. Thornton and Tomes, were elected, and the re-appointment of the Board of Trade auditor, Mr. W. D. W. Lyons, was agreed to. The directors asked that the question of allowing them fees should be left in abeyance.

Brompton and Kensington Electricity Supply Company.

Mr. H. R. Beeton, chairman, presided on Thursday last over the thirteenth ordinary general meeting of the above company, and in moving the adoption of the report, said the duty of presiding at the meetings of the company he was afraid became rather monotonous in virtue of the even tenour of their prosperity. There was little which called for comment in the accounts. With the growth of business there was an all-round increase in the expenditure. The one item in the revenue account which called for particular notice was coal. But for the increase in the price of fuel their works cost would be the lowest they had yet achieved, and even as it was it compared favourably with that of any similar station with the same output. There was an item in the balance-sheet which called for special reference on this occasion. During the past year they had completed the renovation of their station by disposing of the last instalment of their antiquated plant. To accomplish that they had had to write off their capital account from first to last—nearly £27,000—but they had practically now a brand new engine house fitted up with the most modern type of plant, the fruits of which they were reaping, and should continue to reap, in economy of production for many years to come. In disposing rather summarily as they had done of a plant of such value, it must not be supposed that all the machinery in question was worn out, or even that it might not have been profitably utilised for some years, but the fact was that by substituting vertical for horizontal plant they had added so much to the floor space of their engine room as to postpone the necessity for building a new station for a long time to come. The old plant which they had disposed of took up four or five times as much room as that of the same power which they had installed in its place, so that they had not only accommodated plant of larger capacity than they had ever thought possible, but they had still room enough left to relegate the consideration of a second station to a comparatively distant future. By that means they had surmounted the difficulties which confronted them in the early history of their enterprise, and they had laid the foundations of lasting and growing prosperity, so that the directors would be very disappointed if, in their next report, they were unable to recommend an increased distribution of profit. It would be seen from a circular which had been issued to share and debenture stockholders during the last few days, that it was contemplated issuing further capital, whereby their ordinary and preference capital would be raised to £100,000 each. The object of that issue was not merely to provide for immediate capital requirements, but to redeem the debenture stock, which, in their present circumstances, was bearing too high a rate of interest, and the effect of the issue on the terms upon which they had been able to make it, secured them a sufficient amount of premiums to enable them, not only to dispose of the remaining balance of their suspense renewals account, but to materially strengthen their reserves. He had no doubt that next year their reserves would amount to upwards of £30,000. The satisfactory financial position which their directors were able to put before them, was the result of the consistently conservative policy, which, with the approval of the shareholders, they had pursued for the past 10 years, and was largely due to the efficient services of their manager and staff. He believed they were all the observations he had to make upon the accounts, and he would be pleased to answer any questions the shareholders might like to put.

Mr. W. Page seconded the motion.

Replying to a question asked by Captain Matthews, the Chairman said that they had about two months' stock under their present contract, and there was nothing fixed beyond that, so that they could avail themselves of the present price. He did not know the difference between the present price, and that under the existing contract.

Mr. H. W. Bowden, the manager, said it was from 2s. to 3s. per ton.

The Chairman remarked that their coal cost per unit was ·13 of a 1d. higher than last year. There was no doubt that their works cost, in common with other companies, would decline with the present price of coal.

The report was then adopted.

Davis & Timmins, Limited.

The second annual meeting is to be held at Winchester House on March 14th. The report shows the net profit for the year, including £1,683 11s. 3d. brought forward, and after allowing for depreciation, to be £11,356 13s. 3d. The interim dividend paid in September last on the preference shares absorbed £1,724 19s. 3d., leaving a balance of £9,631 14s. to be dealt with, which the directors propose to appropriate as follows:—

To the payment of 6 months' dividend on the preference shares, to December 31st, 1900 (less income-tax) ..	£1,710 0 0
To the payment of a dividend at the rate of 8 per cent. per annum on the ordinary shares for the year ended December 31st, 1900 (less income-tax)	3,587 11 1
To commissions to managers as per agreements	343 5 0
To be placed to general reserve	2,000 0 0
Leaving to be carried forward	1,910 17 11
	£9,631 14 0

The new factory at Wood Green has been completed, and the greater portion of the machinery is in position and employed on productive work.

The Oxford Electric Company.

The directors' report to be submitted to the tenth ordinary general meeting, to be held at Oxford to-day, reads as follows:—

The directors beg to submit their report and accounts for the year ending December 31st, 1900. The revenue account shows a profit (including £73 10s. brought forward from last year) of £5,125 8s. 8d. After providing £1,965 10s. 11d. for debenture and other interest, and writing off £254 0s. 11d. on account of hire purchase installations, the available balance net profit is £2,905 11s. 10d., which your directors propose to appropriate as follows:—In payment of a dividend at the rate of 5 per cent. per annum on the share capital, £2,500, and in adding £250 to the reserve and the renewal of plant account (which will then amount to £2,000), leaving £155 11s. 10d. to be carried forward to next year's account. Since the last report, 3,722 8-c.p. lamps (or their equivalent) have been connected to the mains. This increase compares favourably with the average progress in previous years. The exceptional cost of coal and the increase in the price of materials generally have acted unfavourably on the cost of production. Notwithstanding the reduction in the price of electricity from 7d. to 6d. per Board of Trade unit, which took effect from December 25th, 1899, the revenue from the sale of the current shows an increase of £336 4s. 2d. over that of the preceding year. The number of units sold has been 13 per cent. more than in 1899, and, in view of the number of lamps recently installed and the applications from new customers, there is every reason to anticipate that the rate of increase during the current year will exceed that of 1900. The capacity of the sub-station at North Parade has been doubled to meet the increased demand in the North of Oxford, and the distribution mains of the company have been extended in Farndon, Woodstock, Banbury, St. Margaret's, and Cowley Roads. The plant has been maintained in thoroughly efficient order. To provide for the cost of new plant to meet the growing demands, and other capital expenditure which may be expected during the present year, the directors propose issuing 2,500 shares at par, and prospectus of the issue is enclosed herewith. The retiring directors are Sir Henry C. Mance and Mr. Alderman Robert Buckell, who are eligible for re-election. The auditor, Mr. W. S. Carver, offers himself for re-election.

W. T. Henley's Telegraph Works, Limited.

Mr. Sydney Gedge presided over the ordinary general meeting of the shareholders of this company, held at the Cannon Street Hotel on Thursday in last week, and in moving the adoption of the report, which recommended a dividend of 20 per cent., said that a perusal of the balance-sheet would show that it required no little courage on the part of the directors to meet them that day. He thought they had a balance-sheet which had no rival amongst balance-sheets of any company that year, and it would require very few comments of his upon it. Great pains had been taken in preparing the accounts, and great care had been taken that they should not overstate the doings of the company. In arriving at a gross profit of £99,007 they set aside a sum amply sufficient to cover all risks of every kind with regard to the contracts in existence. No profit had been taken into account but what had been actually earned, and reserve had been made for every liability. They had resisted the temptation to make a profit of £100,000 at the commencement of the new century, but they had come to the melancholy fact that they were going to pay a dividend of 20 per cent. Although that was paid on the small capital of £175,000, there was, of course, more capital than that invested in the business. There was £175,000 preference shares, and also a considerable premium obtained by the issue of ordinary shares from time to time. They would see that the whole of the £25,000 additional capital for last year had been taken up at 100 per cent. premium. There was nothing to say with regard to the creditors of the company. With regard to the reserve fund, they had added £25,000 received on the new issue and transferred £11,000 for profits. As for the £1,000 sinking fund, this was the first year such an item had appeared. They had £50,000 debentures, which were to be repaid by degrees. Last year they had a balance to the credit of profit and loss account of £37,440, and now they had £53,890. On the other side of the account they would see that the freehold land, buildings, machinery, &c., after writing off for depreciation, stood at £21,700 more than last year, but as they had spent £25,000 in addition, they would see that they had not over-estimated the value. The stock-in-trade was more by £30,000, the debtors about £10,000 more, and the bills receivable rather less. The gross profit had risen from £75,000 to £99,000, and the balance carried to profit and loss was £56,411 18s. 6d., as compared with £40,211 last year. A decided improvement was, in fact, shown in every item. The dividend of 15 per cent. which was paid last year absorbed £16,500, and to pay the 20 per cent. which was recommended for the present year would take £25,467, while amongst the preference shareholders £3,712 was to be divided this year compared with £2,086 a year ago. He thought they might all congratulate themselves on the results shown. A perusal of the figures of the five past years showed what steady progress the company had made. In 1896 they had a gross profit of £40,300; in 1897, £46,600; in 1898, £53,692; in 1899, £75,000; and in 1900, £99,000. Then the net profits in 1896 were £20,500: in 1897, £23,900; in 1898, £27,800; in 1899, £40,300; and in 1900, £56,900. They paid 10 per cent. dividend in 1896, 12 per cent. in 1897, 14 per cent. in 1898, 15 per cent. in 1899, and 20 per cent. in 1900. In addition, their reserve fund, which stood at £5,000 five years ago, was now £78,500. In former years it had been their custom to keep back a considerable part of the profits to add to the reserve fund, in order to be prepared for dark days if they should come upon the company, but there was not now the same necessity to keep back the profits, the shareholders having provided the directors with the additional capital that was required. Notwithstanding they were keeping back a sufficient amount of profits. If they continued to go on during the current year as they were at present, he thought the directors would probably pay a little higher interim dividend than 4 per cent. In conclusion, the Chairman spoke in glowing terms of the services of the managing director, Mr. George Sutton, and the whole of the staff.

The Earl of Galloway seconded the motion, and it was agreed to.

The Notting Hill Electric Lighting Company.

The eleventh annual report of the directors reads:—

The directors herewith submit to the shareholders the accounts of the company to December 31st, 1900. The expenditure on capital account, which at the date of the last balance sheet stood at £187,350 18s. 7d., has been increased during the past year by £27,639 9s. 4d., of which the principal items are:—

£19,198 16s. 11d. for new mains (principally the trunk main from Wood Lane to the distributing stations).

£3,336 15s. 6d. for the freehold property in Lancaster Road (bought for the purpose of erecting a subsidiary station to supply the northern portion of Notting Hill).

£3,177 14s. 5d. for the erection of the buildings in Lancaster Road and Bulmer Place, to contain the transforming machinery, and

£8,282 2s. 9d. for the necessary machinery for equipping these stations.

To provide the capital necessary for this expenditure, the balance of £19,000 debentures was issued, and at a general meeting held on August 1st, the capital was increased by £100,000. Of this fresh capital 2,200 £10 shares have been issued to shareholders, at a premium of £2 per share. As it was not possible to carry through the full scheme of extension during the course of the year, the sum of £18,000 remained unspent and is on deposit to meet instalments due to contractors when they mature. The following table shows the progress of the company:—

	Lamps.		£ s. d.
1891 ..	6,056 ..	Loss	554 18 6
1892 ..	9,438 ..	Profit	112 6 1
1893 ..	13,153 ..	"	1,481 7 1
1894 ..	15,669 ..	"	2,101 17 8
1895 ..	20,307 ..	"	3,227 14 10
1896 ..	25,716 ..	"	4,736 9 8
1897 ..	33,000 ..	"	6,854 1 2
1898 ..	46,066 ..	"	7,251 13 7
1899 ..	59,154 ..	"	10,360 17 4
1900 ..	68,505 ..	"	9,856 0 0

The number of consumers is now 1,191, and of these 91 per cent. are supplied at 200 volts.

It will be seen that for the first time the net profit of the company shows a decrease, notwithstanding the fact that the gross revenue showed an increase of 10 per cent. This is accounted for by increase in expenditure for coal £1,000, and by the expenditure of £1,200 on "repairs to accumulators," which involved the entire renewal of one set of batteries. Moreover, in May, the directors found the new works in Wood Lane would not be in working order in time for the winter supply, and therefore they were compelled to refuse fresh supply contracts. The result was that the fresh capital expenditure has been unproductive, and the increase in the number of lamps, which promised to be large, amounted to only 9,400. It is expected that early in the current year the company will resume making fresh connections. From the number of applications already received a large increase may be anticipated. In the South-western portion of the company's area, bounded on the East by the grounds of Holland Park, and comprising Addison Road and its neighbouring streets, a difficulty has arisen. It is intended to supply this district from a transforming station at the southern end of Addison Road, and a suitable long leasehold site was purchased, subject to the consent of the freeholder to the transfer. This consent has been withheld, and it has become necessary for the directors to apply to Parliament to enable them to acquire this site by compulsory powers, as it is necessary for the proper carrying out of their obligations to supply current in this portion of their area. The Bill which is now before Parliament is confined to this one object. At the special general meeting held on the 27th ult., the shareholders passed a resolution approving it, and a notice of the necessary confirmatory meeting to be held after the annual meeting is sent herewith.

In the last report it was stated that in conjunction with the Kensington and Knightsbridge Electric Lighting Company, Limited, a new generating station was to be erected at Wood Lane for supplying current wholesale to the two companies, to be distributed through transforming stations in their respective areas. It was estimated that the cost of these joint works would be £100,000, and this estimate has not been exceeded. The capital was obtained by the issue of special debenture stock, amounting to £100,000, and no part of the capital of our company has been utilised for this purpose. The works are now approaching completion, the machinery is running, and the tests having proved satisfactory, some amount of current is already being supplied to the respective companies. The premium arising from the issue of shares and debentures during the year amounted, after deducting expenses, to £4,257 17s. 7d. The directors have added to this the sum of £742 2s. 5d. out of current revenue, making a total of £5,000, which has been transferred to the depreciation, renewal, and reserve fund, bringing that account up to £11,000. Although the expenditure on the renewal of accumulators might have been taken from this fund, the directors preferred to charge it against the revenue for the year. Of the remaining net profit, after paying interest on the debentures and the new ordinary shares, depreciation, &c., amounting to £7,444 14s. 8d., the directors recommend the payment of the usual dividends of 6 per cent. on both the preference and ordinary shares, amounting to £5,670. Of the balance, according to the articles of association, one half, amounting to £887 7s. 4d., is credited to the holders of the founders' shares, and the other half to the ordinary and preference shares. This will enable a further 1 per cent. to be paid on both ordinary and preference, with a distribution of £1 12s. per share on the founders' shares. An interim dividend of 3 per cent. was paid on July 1st, and the balance of 4 per cent. will be paid forthwith, together with the distribution on the founders' shares. The preference shares having received their full 6 per cent., the 1 per cent. bonus will be added to the interim dividend on these shares, to be paid on July 1st next.

The directors desire to place on record their appreciation of the services of the engineer and manager, secretary and staff generally; the amount of extra work thrown upon them in connection with the construction of the joint station and of the subsidiary stations has been very large, and has been ably carried out. They desire also to express their satisfaction at the friendly assistance they have received in all matters connected with the joint station from the directors and staff of the Kensington and Knightsbridge Electric Lighting Company, Limited. The directors retiring in rotation are Messrs. Alexander Howden and J. W. Swan, who, being eligible, offer themselves for re-election. The shareholders will recollect that on the occasion of the last meeting Mr. J. W. Swan, F.R.S., was elected a director to replace the late Mr. Francis Radford. The shareholders' auditors, Messrs. Fox, Sissons & Co., retire, and being eligible, offer themselves for re-election. The accounts will be audited in due course on behalf of the Board of Trade.

The annual meeting is to be held at Notting Hill Gate on Tuesday, March 19th, at 5.30 p.m.

Cambridge Electric Supply Company.

The annual general meeting was held at the company's registered offices on Friday afternoon. The chairman of the directors (Mr. D. Munsey) presided.

The Chairman proposed the adoption of the report.

The Hon. C. A. Parsons, in seconding, remarked that the company owed a great deal to Mr. Barker, who was shortly leaving them to go to Newcastle-on-Tyne to manage the works where their machinery was made. Mr. Harvey, their new engineer, was a gentleman in whom they had every confidence.

The Chairman said that the secretarial duties would be carried out by Mr. Wynne.

The report was adopted.

Mr. D. Munsey and Dr. Latham were unanimously re-elected directors, and Mr. A. Rutter auditor.

The Chairman remarked that they were all exceedingly sorry to lose Mr. Barker, and

Mr. A. W. Smith, on behalf of the shareholders, expressed appreciation of Mr. Barker's services.

Charing Cross, Euston, and Hampstead Railway Company.

A special meeting was held on 4th inst. at Clement's Lane, E.C., Mr. W. E. Jones presiding. Resolutions were passed approving Bills:—

1. For conferring further powers upon the company and authorising agreements with the Brompton and Piccadilly Circus and the Central London Railway Companies.
2. To empower the company to extend their authorised railways to Highgate and Victoria, and for authorising agreements with the Midland, the Central London, the Baker Street and Waterloo, the Brighton, and the Victoria and Pimlico Railway Companies, and the South-Eastern and Chatham Railway Companies' managing committee; and
3. For incorporating and conferring powers on the Finchley and Hendon Tramways Company.

Prospectus.—The Brompton and Kensington Electricity Supply Company has been inviting applications for an issue of 8,000 7 per cent. cumulative preference shares of £5 each at £8 per share. The list closed on Monday.

National Telephone Company.—A meeting of this Company was held yesterday to confirm the special resolutions passed at the general meeting.

TRAFFIC RECEIPTS.

Blackpool and Fleetwood Tramroad Company.—The receipts for the week ending March 2nd were £139; corresponding week last year £177; decrease, £38. Total to date, £1,288; corresponding period last year, £1,290; decrease, £2.

Bristol Tramways and Carriage Company.—The receipts for the week ending March 7th were £3,670 13s. 1d.; corresponding period last year, £2,743 0s. 6d.; increase, £927 12s. 7d.

Central London Railway.—The receipts for the week ending March 2nd, were £6 028; previous week, £5,941; increase, £87. Total receipts to date (9 weeks), £54,207. Miles open, 6.

City and South London Railway.—The receipts for the week ending March 3rd were £1,985; corresponding week last year, £1,479 (Moorgate extension open); increase, £52. Total to date, £17,073; corresponding period last year, £10,473; increase. £7,600. Miles open, 1901, 4¾; 1900, 3¾.

Dover Corporation Tramways.—The receipts for the week ending March 2nd were £185 15s. 5½d.; corresponding week last year, £139 16s. 9d.; increase, £18 18s. 8½d. Total to date, £1,973 18s. 4d.; corresponding period last year, £1,809 17s. 7d.; increase, £63 15s. 9d. Miles of track open, 3; Car miles run, 1901, 4,976; 1900, 4,909. Number of cars, 11.

Dublin United Tramways Company.—The receipts for the week ending March 1st were as follows:—D. U. T. Co., electric cars, £3,040 15s. 6d.; D. S. D. Co., electric cars, £642 19s. 10d.; total £3,683 15s. 4d.; corresponding week last year—D. U. T. Co., electric cars, £2,938 18s. 0d.; ditto, horse cars, £50 15s. 3d.; D. S. D. Co., electric cars, £639 15s. 2d.; total, £3,629 8s. 5d.; increase, £54 11s. 11d.; aggregate to date, £32,463 13s. 5d.; aggregate to date last year, £29,773 17s. 3d.; increase, £2,689 16s. 2d. The mileage worked is 45 miles electrically, as against 42 miles electrically, 2 miles by horses, for the corresponding period last year.

Liverpool Overhead Railway.—The receipts for the week ending March 3rd were £1,431; corresponding week last year, £1,432; decrease, £1. Total to date, £13,183; corresponding period last year, £12,932; increase, £256. Miles open, 6 miles 57 chains.

STOCKS AND SHARES.

Wednesday Evening.

The easier tendency of the Money Market as a beneficial influence over markets has been offset by a dearth of business. Consequently our price lists record few alterations other than those arising from the quotation of various securities *ex* dividend. Over a dozen prices in the electrical section were shorn of their dividends on the last Stock Exchange account-day, February 28th, and in the majority of cases the loss has not been made good up to the present. On the whole, the general trend is towards lower values, for which the lack of public interest in the market is mainly responsible. Supply shares are easier, the passing of the City of London Ordinary dividend—although not unexpected—creating a bad impression, and depressing the market all round. Electric Railway stocks and shares maintain their prices. Manufacturing investments show a disposition to recede a trifle after their jump in the last three weeks. Telegraph stocks have steadied again, but telephone shares are unable to stand against the continual stream of sales that pours into the market.

Brompton and Kensington Ordinary and Preference both show a loss of 10s., due to the quoting of the shares *ex* the right to apply for the new issue of Preference at £8 per share. This emission has apparently proved popular with proprietors of Bromptons, and on the basis of ¼ to ½ premium a good many shares are changing hands. Chelseas are again dull, not having recovered from the effects of the company's report yet, and Metropolitans have dropped the 10s. which they added to their price last week. At the meeting on Tuesday the chairman of the Metropolitan referred to the threatened action of the Marylebone Borough Council as "confiscation, not competition." As we have previously pointed out, it has been the fear of what the lately-constituted body might do which has kept the quotation of Metropolitans comparatively so low for the past six months.

City of London shares have fallen as low as 6 since we last wrote, but buyers have now come along and the price has recovered to some extent, although showing a loss on the week. Now that the dividend has been passed, and the worst, therefore, known for another year, there are some who already discount the City company's outlook for the current twelvemonths, and profess to see signs of a break in the heavy clouds which have enveloped it so long. Moreover, we hear whispers of changes on the board, and the market is discounting the effect of that too.

Westminster Electrics are quoted *ex* dividend, both old and new the deductions amounting to 5s. 6d. and 1s. 4½d. respectively, and the prices of each class remain unchanged, thus showing advances of the dividend amounts. In the suburban and provincial list, Blackheath and Greenwich Electric Ordinary are quoted at 10s., the Debenture stock, 75 per cent. paid, is 72½; Bournemouth and Poole Ordinary and Preference are 13 and 10½ respectively. (We wonder what has become of those suggestions that the company should be taken over by the local authorities.) Folkestone Ordinary at 5¾ for the £5 shares, and Hove Ordinary at 8 for shares of like denomination, are exceedingly firm, while Oxford Electric Ordinary remain at 6; they also are £5 shares. The 5 per cent. Debenture stock of the River Plate Electric Lighting and Traction Company stands at 30 per cent. discount, which is not surprising when one remembers that the date of the last interest payment was June, 1899.

Beyond a fall in the price of Direct United States Cable shares, the Anglo-American group of telegraph securities is almost motionless. Anglo "A" is ¼ weaker, and the company's other stocks are both a point off. The Marconi scare, as we suggested last week, is overdone. Those new offices of the Anglo-American Telegraph Company, cheek by jowl with the Yankee market of the Stock Exchange, are proving a boon to "House" members, and remunerative to the company. The Far Eastern group is also very little affected, falls of a point in Eastern Ordinary and 3½ per cent. Preference stock being the only recordable changes. West African Telegraph Debentures, now *ex* 2½ per cent., are ½ better on the week, allowing for the coupon, and although Mr. Chamberlain's strictures on West African mining enterprises have temporarily killed business in the shares, the market will revive again, and these Telegraph Debentures look speculatively worth having. London-Platino-Brazilian 6 per cent. Debentures are down 1 per cent. nominally, but really two points higher actually, the price being made *ex* interest on March 1st. They are redeemable three years hence.

Bearing very largely upon the fortunes of electric lighting and telegraph companies is the outlook for the copper market. Rio Tinto shares, the leading copper descriptions dealt in by London, have this week attained the record quotation of 61—they are £5 shares—and the price of the metal is almost as high as ever it was. Nor does there appear to be any immediate prospect of its declining. The market in copper is controlled by that vast American Trust which was evolved some two years since, and despite all that newspaper critics may say, the syndicate has kept up the metal to what would have been considered a ridiculous level but a decade since. That there is any chance of a fall in copper we cannot see, and the companies which use it in their businesses must face the unwelcome fact. Economies will have to be practised elsewhere: we fear that it is quite impossible for shareholders and investors in electrical enterprises to look with any certain hope for cheaper copper during 1901.

British Electric Traction new shares are commanding a free and liquid market. For special settlement the price is ¼ to ½ premium; for money it is ½ less. The old shares show no alteration, neither do Potteries Ordinary at 12, nor New General Tractions at 3¾. Buenos Ayres and Belgrano "A" Preference are a shade harder at 5½, and a good deal of business is being done in them. Calcutta Trams are 11; Blackpool and Fleetwood 14½.

Manufacturing shares display signs of slackening strength, both Callender's and British Insulated Wire being down 10s. Edison and Swan, however, have quickly recovered the dividend deduction, and Telegraph Construction are 40, *ex* bonus and dividend. National Telephones are weaker, as usual, and the two classes of Preference are both quoted at 11 to 13 *ex* dividend. The Ordinary at 3¼ might tempt a purchaser who does not mind running considerable risk for the sake of good interest on his money.

SHARE LIST OF ELECTRICAL COMPANIES.—TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. †	Dividends for the last three years. 1898.	1899.	1900.	Closing Quotations Feb. 27th.	Closing Quotation March 6th.	Business done during week ended March 6th, 1901. Highest.	Lowest.
96,900	African Direct Telegraph, 4 % Debs.	100	...	...	...	99 —102	99 —102	...	...
119,700	Amazon Telegraph 5 % Debs., Nos. 1 to 1,250 Red. ...	100	...	...	...	55 — 65	55 — 65	...	...
822,700	Anglo-American Telegraph	Stock	£3 9s.	73/6	3⅛%	52 — 55	51 — 54	52¼	...
3,088,540	Do. do. 6 % Pref.	Stock	6 %	6 %	6 %	97 — 99	96 — 98	98	97
3,088,540	Do. do. Deferred	Stock	18s. %	£1 7s.	5s.%	8¾— 9¼	8½— 9	9	8 1/16
44,000	Chili Telephone, Nos. 1 to 44,000	5	3 %	4 %	...	3 — 3½	3 — 3⅛	...	...
13,333,300$	Commercial Cable	$100	8 %	8 %	...	165 —175	165 —175	...	...
1,589,496£	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	...	...	...	102 —104	102 —104	102½	...
16,000	Cuba Telegraph	10	8 %	7 %	...	7½— 8½	7½— 8½	8⅜	7⅛
6,000	Do. 10 % Pref.	10	10 %	...	...	16 — 17	16 — 17	...	...
12,931	Direct Spanish Telegraph	5	4 %	4 %	...	3½— 4½	3½— 4½	...	...
6,000	Do. do. 10 % Cum. Pref.	5	...	...	...	9 — 10	9 — 10	...	...
30,000	Do. do. 4½ % Debs.	50	...	...	...	100 — 104%	100 —104%	...	...
60,710£	Direct United States Cable	20	3½%	3 %	3 %	10 — 10½	9⅞— 10¼	10 3/16	9 15/16
108,300	Direct West India Cable, 4½ % Reg. Deb.	100	...	...	...	99 —102	99 —102	...	...
4,000,000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %	...	145 —150	144 —149	147	145½
1,826,888	Do. 3½ % Pref. Stock	100	...	...	...	95 — 98	94 — 97	94½	94
1,432,268£	Do. 4 % Mort. Deb. Stock Red.	Stock	...	...	...	113 —117	113 —117	113½	113
250,000	Eastern Extension, Australasia, and China Telegraph ...	10	7 %	7 %	...	14½— 14⅝	14½— 14⅝	14⅝	14 5/16
50,000	Do. Nos. 250,001 to 300,000 (iss. at £3 pm. all pd.) ...	10	...	...	...	13⅝— 14¼	13⅝— 14¼	14⅝	13½
320,000£	Do. 4 % Deb. Stock	Stock	...	...	...	110 —115	110 —115	...	...
300,000£	Eastern and South African Telegraph, 4 % Mort. Deb. Nos. 1 to 3,000, red. 1909	100	...	...	...	99 —102	99 —102	...	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1—8,000	25	...	...	...	101 —104%	101 —104%	101	...
180,227	Globe Telegraph and Trust	10	5⅛%	5¼%	...	9⅝— 10¼	9⅝— 10¼	10⅛	9 13/16
180,042	Do. do. 6 % Pref.	10	6 %	...	...	14⅜— 15¼	14⅜— 15¼	15	14⅜
150,000	Great Northern Telegraph, of Copenhagen	10	12½%	...	...	32 — 34	32 — 34	33¼	...
82,000	Halifax and Bermuda Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	...	...	...	99 —102	99 —102	...	...
17,000	Indo-European Telegraph	25	10 %	10 %	...	47 — 51	47 — 51	...	...
100,000£	London Platino-Brazilian Telegraph, 6 % Debs.	100	...	...	...	104 —107	103 —106 xd	...	...
72,680	Montevideo Telephone, Limited, Ord., Nos. 1 to 72,680 ...	1	...	2½%	...	¼— ⅜	¼— ⅜	...	...
86,492	Do. do. do. 5 % Pref., Nos. 1 to 86,492	1	4 %	5 %	...	⅝— 1	⅝— 1	...	...
590,000	National Telephone, 1 to 590,000	5	6 %	5 %	5 %	3½— 3⅝	3⅜— 3⅝xd	3⅝	3⅛
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	12 — 14	11 — 13 xd	12½	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	11 — 13	11 — 13 xd	11	...
250,000	Do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	5 %	5 %	4⅜— 5	4½— 4⅝xd	4 9/16	4 7/16
2,000,000£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	94 — 97	94 — 97	95½	...
500,000	Do. 4 % Deb. Stock Red.	100	...	...	4 %	98 —101	98 —101	99½	99
171,504	Oriental Telephone and Elec., Nos. 1 to 171,504, fully paid	1	5 %	5 %	...	⅞— 1⅛	⅞— 1⅛	...	...
100,000£	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000 ...	100	...	...	...	99 —102	99 —102	...	...
11,839	Reuter's	8	5 %	5 %	...	7½— 8½	7½— 8½	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	124 —129	124 —129	...	...
58,000	United River Plate Telephone	5	6 %	7 %	...	4½— 5	4½— 5	4⅝	4½
40,000	Do. do. 5 % Cum. pref. Nos. 1—40,000	5	...	...	...	4⅝— 5¼	4⅝— 5¼	...	...
179,947	Do. do. 5 % Debs.	Stock	...	...	...	103 —106	103 —106	104	...
171,000	West African Telegraph, 5 % Debs....	100	...	...	...	99 —102	97 —100 xd	...	...
30,008	West Coast of America, Nos. 1—30,000 and 53,001—53,008	2½	...	...	...	½— ⅝	½— ⅝	...	...
150,000	Do. do. 4 % Debs., 1—1,500 gua. by Braz. Sub. Tel.	100	...	...	...	99 —102	99 —102	..	...
207,930	Western Telegraph, Ltd., Nos. 1—207,930	10	7 %	7 %	...	13⅜— 14¼	13⅜— 14¼	14¼	13⅞
75,000	Do do. 5 % Debs. 2nd series, 1906 ...	100	...	...	...	101 —104	101 —104	...	...
348,777	Do. do. 4 % Deb. Stock Red.	100	...	...	...	102 —105	102 —105	...	...
88,321	West India and Panama Telegraph	10	2 %	⅝%	...	⅝— ¾	⅝— ¾	...	...
34,563	Do. do. do. 6 % Cum. 1st Pref. ...	10	...	...	...	6 — 7	6 — 7	6⅛	...
4,669	Do. do. do. 6 % Cum. 2nd Pref. ...	10	...	...	...	5 — 7	5 — 7	...	...
80,000£	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	...	...	...	103 —106	103 —106	...	...

ELECTRICITY SUPPLY COMPANIES.

19,661	Brompton & Kensington Elec. Lt. Sup., Ord., 101 to 19,761	5	6 %	6 %	6 %	7½— 8½	7 — 8	7⅞	7½
12,000	Do. do. 7 % Cum. Pref....	5	...	...	...	8½— 9½	8 — 9	8⅝	7⅞
50,000	Charing Cross and Strand Electricity Supply	5	8 %	9 %	9 %	9½— 10½	9½— 10½	10⅛	...
20,000	Do. do. do. do. 4½% Cum. Pref.	5	...	...	....	5½— 5⅝	5½— 5⅝	5½	...
34,000	*Chelsea Electricity Supply, Ord.	5	6 %	6 %	5½%	6¼— 6⅜	6 — 6½	6	...
150,000	Do. do. do. % Deb. Stock Red. ...	Stock	...	...	...	109 —112	109 —112	...	...
70,579	City of London Electric Lighting, Ord. 40,001—110,579...	10	6 %	4 %	...	7 — 8	6½— 7½	7	6⅞
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	...	...	13 — 14	13 — 14	13	...
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	...	...	...	122 —127	122 —127	124½	123½
40,000	County of Lond. & Brush Prov. Elec. Ltg., Ord. 1—40,000	10	*nil*	4 %	...	8 — 9	8 — 9	8	...
20,000	Do. do. do. 6 % Pref., 40,001—60,000	10	6 %	...	...	11½— 12½	11½— 12½	...	...
200,000	Do. 4½ % Deb. Stock, Prov. Certs (all paid) Rd. ...	...	...	...	...	106 —109	106 —109	...	...
35,500	Edmundson's Elec. Corp., Ord. Shares	5	7 %	...	...	4¾— 5¼	4¾— 5¼	...	...
75,000	Do. do. 4½ % 1st Mort. Deb. Stock. ...	100	...	...	...	103 —106	103 —106	...	...
110,000	London Electric Supply Corporation, Limited, Ord. ...	3	...	...	...	1½— 2	1½— 2	...	...
49,840	Do. do. do. do. 6 % Pref.	5	6 %	...	...	4 — 5	4 — 5	...	...
250,000	Do. do. do. 4% 1st Mt. Db. Stock Rd.	Stock	...	...	...	98 —101	98 —101	98¾	...
85,000	Metropolitan Electric Supply, 101 to 62,500	10	5 %	5 %	6 %	13 — 14	12½— 13½	13¼	13 3/16
220,000£	Do. 4½% First Mortgage Debenture Stock	...	...	...	...	110 —113	110 —113	...	...
250,000	Do. 3½% Mort. Deb. Stock Red.	Stock	...	...	...	96 — 99	96 — 99	99	98½
6,452	Notting Hill Electric Lighting	10	6 %	7 %	7 %	15½— 16½	15½— 16½	...	...
40,000	St. James's and Pall Mall Electric Light, Ord.	5	14½%	14½%	14½%	14 — 15	14 — 15	14 7/16	14¼
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	8½— 9½	8½— 9½	...	...
150,000	Do. do. 3½ % Deb. Stock Red. ...	100	...	...	...	98 —101	98 —101	100⅜	100
12,000	Smithfield Market Elect. Supply, Ord.	5	...	...	...	2 — 2½	2 — 2½	2	...
50,000	Do. do. 4 % Deb.	100	...	...	...	80 — 90	80 — 90	...	...
65,000	South London Electricity Supply, Ord.	5	...	...	...	2½— 3½	2½— 3½	...	...
79,900	Westminster Electric Supply, Ord., 101 to 80,000... ...	5	12 %	13 %	10½%	12 — 13	12 — 13 xd	12½	12¼

* Subject to Founders Shares.
Unless otherwise stated all shares are fully paid.
Dividends marked † are for a year consisting of the latter part of one year and the first part of the next.

Quotations on Liverpool Stock Exchange.
‖ Dividends paid in deferred share warrants, profits being used as capital.

SHARE LIST OF ELECTRICAL COMPANIES.—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL COMPANIES.

Present Issue.	NAME.	Stock or Share.	Dividends for the last three years. 1898.	1899.	1900.	Closing Quotation Feb. 27th.	Closing Quotation Mar. 6th.	Business done week ended Mar. 6th, 1901. Highest	Lowest
		‡							
20,000	British Aluminium 7 % Cum. Pref.	10	...	...	...	8 — 9	8 — 9	...	...
300,000	Do. do. 5 % 1st Mort. Deb. Stock Red. ...	Stock	...	...	...	91 — 95	91 — 95	...	...
45,000	British Electric Traction	10	6 %	...	...	14½— 15½	14½— 15½	14½	...
50,000	Do. do. 6 % Cum. Pref.	10	...	...	...	11½— 12½	11½— 12½	...	...
350,000	Do. do. 5 % Perpetual Debenture Stock ...	Stock	...	...	...	120 —123	120 —123	...	...
85,000*l*	†British Electric Works Co., Ord. £1 shares, 50,001—135,000	...	...	...	...	1/16— 3/16	1/16— 3/16	...	...
50,000	† Do do. 6 % Cum. Pref., 1—50,000 ...	...	...	...	...	3/16— 5/16	3/16— 5/16	...	...
500	† Do. do. 4½ % 1st Mort. Deb.	100	...	...	...	85 — 90	85 — 90	...	...
70,000	British Insulated Wire Ord.	5	15 %	20 %	15 %	11 — 12	10 — 11 xd	10½	...
70,000	Do. do. 6 % Cum. Pref.	5	...	...	...	5⅝— 6¼	5⅝— 6¼	...	...
90,000	Brush Elecl. Enging., Ord., 1 to 90,000	2	5 %	6 %	...	1⅝— 1⅞	1⅝— 1⅞	1⅞	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000 ...	2	6 %	6 %	...	2⅛— 2⅜	2⅛— 2⅜	2 5/16	...
125,000*l*	Do. do. 4½ % Perp. Deb. Stock	Stock	...	...	...	105 —110	103 —108 xd	107	...
108,710	Do. do. 4½ % Perp. 2nd Deb. Stock ...	Stock	...	...	...	101 —103	101 —103	...	...
30,000	Callender's Cable Construction shares, Nos. 1—30,000 ...	5	15 %	15 %	...	15½— 16½	15 — 16	16 3/16	14⅜
40,000	Do. do. 5 % Cum. Pref.	5	...	...	...	5½— 6	5½— 6	...	...
90,000	Do. do. 4½ % 1st Mort. Deb. Stock Red ...	Stock	...	...	...	109 —113	109 —113	...	...
206,297	Central London Railway, Ord. Shares	10	...	...	...	9 — 9⅛	9 — 9⅛	9 5/16	...
78,703	Do. do. Pref. half-shares	5	...	...	...	4⅜— 5¼	4⅜— 5¼	5	4⅜
78,703	Do. do. Def. do.	5	...	...	...	4 — 4¼	4 — 4¼	4¼	...
855,000	City and South London Railway	Stock	2⅛%	1⅞%	1¼%	46 — 50	46 — 50	...	...
37,500	Do. do. Ord. shares Nos. 22,501 to 60,000	10	...	...	...	4 — 5	4 — 5	4⅝	...
54,000	Crompton & Co., Nos. 1 to 54,000	3	6 %	7½%	...	3½— 3⅝	3½— 3⅝	3 9/16	3 5/16
100,000	Do. 5 % 1st Mort. Reg. Debs., 1 to 900 of £100, and 901 to 11,000 of £50 red	...	...	...	...	100 —103	100 —103	...	...
99,261	Edison & Swan Utd. El. Lgt., "A" shares, £3 pd. 1 to 99,261	5	6 %	6 %	...	1½— 2	1½— 2 xd	1⅝	...
17,139	Do. do. do. "A" Shares, 01—017,139 ...	5	6 %	6 %	...	3½— 4½	3½— 4½xd	...	...
344,023	Do. do. do. 4 % Deb. Stock Red ...	100	...	...	...	88 — 90	88 — 90	...	...
100,000	Do. do. 5% 2nd Deb. Stock Prov. Certs. all pd.	100	...	...	...	96 —100	96 —100	...	...
112,100	Electric Construction, 1 to 112,100	2	6 %	6 %	...	1⅞— 2⅛	1⅞— 2⅛	...	...
25,000	Do. do. 7 % Cum. Pref., 1 to 25,000... ...	2	7 %	...	...	2⅛— 3	2⅛— 3	...	...
182,500	Do. do. 4 % Perp. 1st Mort. Deb. Stock ...	Stock	...	...	...	101 —104	101 —104	...	...
9,600*l*	Greenwood & Batley, 7 % Cum. Pref., 1 to 9,600	10	7 %	7 %	...	10 — 11	10 — 11	...	...
35,000	Henley's (W. T.) Telegraph Works, Ord.	5	14 %	15 %	20 %	16 — 17	16 — 17	16⅜	16¼
35,000	Do. do. do. 4½ % Pref.	5	7 %	...	...	5½— 6	5½— 6	5⅝	5 9/16
50,000	Do. do. do. 4½ Mort. Deb. Stock...	Stock	...	...	...	109 —113	107 —111 xd	...	...
50,000	India-Rubber, Gutta-Percha and Telegraph Works ...	10	10 %	10 %	...	20½— 21½	20½— 21½	21⅛	20⅞
300,000	Do. do. do. 4 % 1st Mort. Deb	100	...	...	...	101 —104	101 —104	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	3¼%	3¾%	3¼%	8 — 8⅛	7⅞ — 8	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5	...	13 — 14	13 — 13½	...	...
37,350	Telegraph Construction and Maintenance	12	15 %	15 %	17½%	41 — 45	38 — 42	41	39
150,000	Do. 4 % Deb. Bds. Nos. 1 to 1,500 Red. 1909 ...	100	...	... %	...	101 —104	101 —104	...	...
20,000	Telegraph Manufacturing, Ord. Nos. 1 to 20,000	5	8 %	12 %	...	11 — 12	11 — 12	11 2/32	11⅛
20,000	Do. do. 5 % Cm. Prf. Nos. 1 to 20,000...	5	...	...	...	5½— 6	5½— 6	5 13/16	5⅝
540,000*l*	Waterloo and City Railway, Ord. Stock	100	3 %	3 %	3 %	93 — 96	93 — 96	...	...

† Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Brompton and Kensington, 4½ % Debentures of £100, 101—104.
Consolidated Telephone Construction and Maintenance, 3/—4/-
National Electric Free Wiring, 12/6 paid, 1/8—1/2.
Oldham, Ashton, and Hyde Electric (£10 pd.), Ord., 15½—16½.
Do. do. Pref. (£10 pd.), 10—10½.

* From Birmingham Share List.

Kensington and Knightsbridge Electric Lighting, Ordinary Shares £5 (fully paid) 11—12; 1st Preference Cumulative 6 % £5 (fully paid), 6½—7 Debentures, 101—104. Dividend, 1900, on Ordinary Shares 12 %.
*T. Parker, £10 (fully paid), 16½.

Bank rate of discount 4 per cent. (February 21st, 1901).

MARKET QUOTATIONS, Wednesday, March 6th.

CHEMICALS, &c.		This week.	Last week.	Inc. or Dec.
a Acid, Hydrochloric	per cwt.	5/-	5/-	..
a ,, Nitric	per cwt.	23/-	23/-	..
a ,, Oxalic	per cwt.	33/-	33/-	..
a ,, Sulphuric	per cwt.	5/6	5/6	..
a Ammoniac, Sal	per cwt.	39/-	39/-	..
a Ammonia, Muriate (crystal) ..	per ton	£33 10	£33 10	..
a ,, ,, ..	per ton	£30	£30	..
a Bleaching powder	per ton	£7	£7	..
a Bisulphide of Carbon	per ton	£15	£15	..
a Borax	per ton	£17 10	£17 10	..
a Benzole (90 %)	per gal.	7/-	7/-	..
a ,, (50/90%)..	per gal.	5/6	5/6	..
a Copper Sulphate	per ton	£25	£25	..
a Lead, Nitrate	per ton	£25	£25	..
a ,, White Sugar	per ton	£31	£31	..
a ,, Peroxide	per ton	£27 10	£27 10	..
a Methylated Spirit	per gal.	2/6	2/6	..
a Naphtha, Solvent (90% at 160° C).	per gal.	5/6	5/6	..
a Potash, Bichromate, in casks..	per lb.	8½d.	8½d.	..
a ,, Caustic (75/80%) ..	per ton	£24	£24	..
a ,, Bisulphate	per ton	£85	£85	..
a Shellac	per cwt.	64/-	64/-	..
a Sulphate of Magnesia	per ton	£4 10	£4 10	..
a Sulphur, Sublimed Flowers ..	per ton	£6 5s.	£6	..
a ,, Recovered	per ton	£5 10	£5 10	..
a ,, Lump	per ton	£5	£5	..
a Soda, Caustic (white 70 %) ..	per ton	£10 15	£10 15	..
a ,, Crystals	per ton	£3	£3	..
,, Bichromate, casks ..	per lb.	2¾d.	2¾d.	..
METALS, &c.				
b Aluminium Wire, in ton lots..	per ton	£224	£224	..
b ,, Sheet, in ton lots	per ton	£191	£191	..
p Babbitt's metal ingots.. ..	per ton	£80 to £145	£80 to £145	..
c Brass (rolled metal 2" to 12") basis	per lb.	7¾d.	7¾d.	..
c ,, Tube (brazed)	per lb.	10d.	10d.	..
c ,, ,, (solid drawn) ..	per lb.	8½d.	8½d.	..
c ,, Wire, basis	per lb.	8½d.	8½d.	..
c Copper Tubes (brazed) ..	per lb.	11d.	11d.	..
c ,, ,, (solid drawn) ..	per lb.	10½d.	10½d.	..
g Copper Bars (best selected) ..	per ton	£86	£86	..

METALS, &c. *(continued.)*		This week	Last week.	Inc. or Dec.
g Copper Sheet	per ton	£86	£86	..
g ,, Rod	per ton	£86	£86	..
e ,, (Electrolytic) Bars ..	per ton	£83	£83	..
e ,, ,, Sheets ..	per ton	£90	£90	..
e ,, ,, Rod ..	per ton	£84	£84	..
e ,, ,, H.C. Wire	per lb.	9½d.	9½d.	..
f Ebonite Rod	per lb.	8/-	8/-	..
f ,, Sheet	per lb.	5/-	5/-	..
n German Silver Wire	per lb.	1/6	1/6	..
h Gutta-percha fine	per lb.	8/-	8/-	..
h India-rubber, Para fine	per lb.	3.6½	3/10½	4d. dec.
i Iron, Charcoal Sheets	per ton	£18	£18	..
i ,, Pig (Cleveland warrants) ..	per ton	45 9	46 3	6d. dec.
i ,, Forgings, according to size	per ton	From £11	From £11	..
i ,, Scrap, heavy	per ton	70/- to 72/6	70/- to 72/6	..
i ,, Wire, galvanised No. 8 ..	per ton	£10 5	£10 5	..
g Lead, English Ingot	per ton	£13 15 to £13 17 6	£14 10	12s. dec.
g ,, ,, Sheet	per ton	£17 15	£17 15	..
m Manganin Wire No. 28	per lb.	8/-	8/-	..
g Mercury	per bot.	£9 2 6	£9 2 6	..
d Mica (in original cases), small ..	per lb.	8d. to 9d.	8d. to 9d.	..
d ,, ,, ,, medium	per lb.	1/9 to 2/9	1/9 to 2/9	..
d ,, ,, ,, large ..	per lb.	3/3 to 7/3	3/3 to 7/3	..
p Phosphor Bronze, plain castings	per lb.	1.0½ to 1.3	1.0½ to 1.3	..
p ,, rolled bars & rods	per lb.	1/1 to 1/4	1/1 to 1/4	..
p ,, ,, strip & sheet	per lb.	From 1/3	From 1/3	..
o Platinum	per oz.	£4	£4	..
p Silicium Bronze Wire	per lb.	10½d. to 1/1	10½d. to 1/3	..
i Steel, Magnet, acc'd'ng to desc'p'n	per ton	From £15 to £40	From £15 to £40	..
i ,, ,, in bars		£58	£58	..
g Tin, block	per ton	£124 to £125	£125 10 to £126 10	30s. dec.
g ,, foil	per lb.	1/6	1/6	..
n ,, wire, Nos. 1 to 16	per lb.	1/9	1/9	..
p White Anti-friction Metals — "White Ant" brand	per ton	£40 to £70	£40 to £70	..
j Yarns, Cotton, Single 10 lb. b'ndl's	per lb.	9½d.	9½d.	..
j ,, Best Flax, 6 lea.	per lb.	6d.	6d.	..
j ,, Hemp, 3 ply 10 lbs. ..	per lb.	4½d.	4½d.	..
j ,, ,, Russian, 10 lbs. ..	per lb.	5½d.	5½d.	..
j ,, Jute, 180 lbs. rove ..	per ton	£14 10	£14 10	..
k Zinc, Sh't. (Vielle Montagne ond.)	per ton	£21 12 6	£21 12 6	..

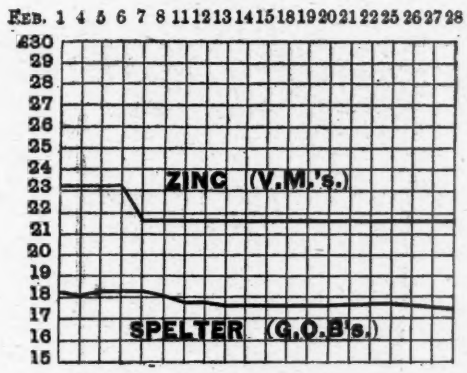
Quotations supplied by { *a* Messrs. G. Boor & Co. *b* The British Aluminium Co., Ltd. *c* Messrs. Thos. Bolton & Sons. *d* Messrs. F. Wiggins & Sons. *e* Messrs. Frederick Smith & Co.

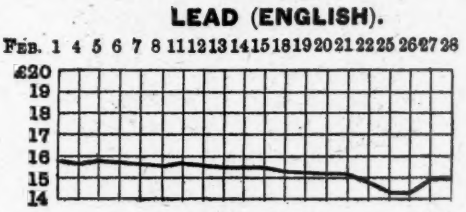
Quotations supplied by { *f* India-Rubber, G.-P. and Teleg. Works *g* Messrs. James & Shakspeare. [Co., Ltd. *h* Messrs. Jackson & Till. *i* Messrs. Belling & Lowe. *j* Messrs. Henry C. Yee & Co.

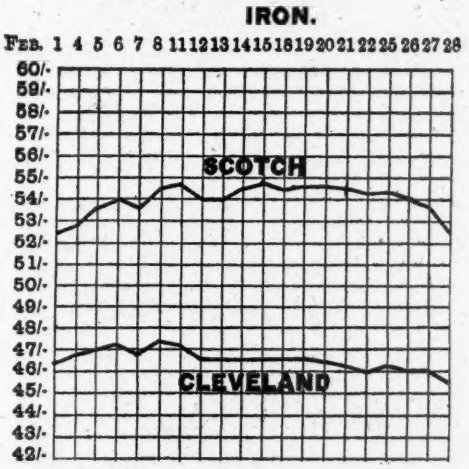
Quotations supplied by { *k* Messrs. Morris Ashby, Limited *m* Messrs. W. T. Glover & Co., Ltd. *n* Messrs. P. Ormiston & Sons. *o* Messrs. Johnson, Matthey & Co., Ltd. *p* The Phosphor Bronze Company, Ltd.

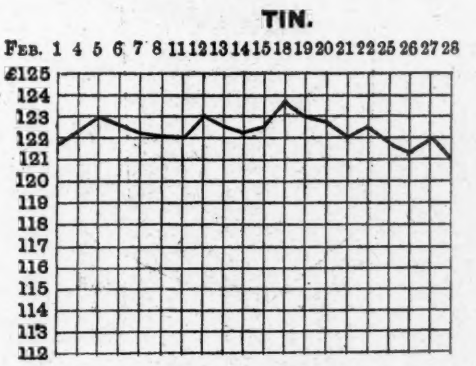
METAL MARKET.

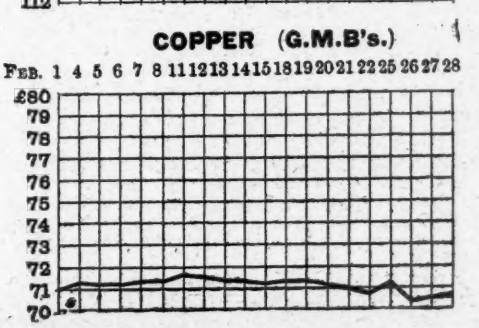
Fluctuations in February.











UP-TO-DATE TRANSFORMER DESIGN.

One of the chief objections raised to the alternating current system in its early days was the unreliability of its transformers. The simplicity of the converting apparatus was persistently urged by the pioneers of single-phase alternating current systems, but although their statements in this direction were fully endorsed, a great number of engineers were apt to put reliability before simplicity.

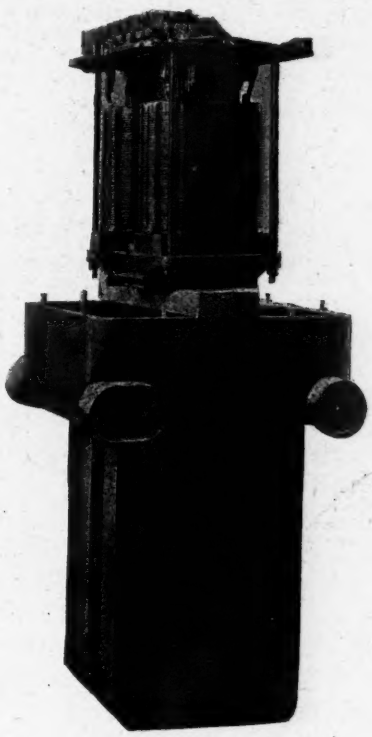


Fig. 1.

That there were just causes for complaint against the design of early transformers goes almost without saying, but it is equally true that every effort has been made since that time by manufacturers to so improve their designs that further cause for annoyance may be removed.

Some makers have sacrificed much of the mechanical stability for electrical efficiency, the latter ofttimes being only attained by the

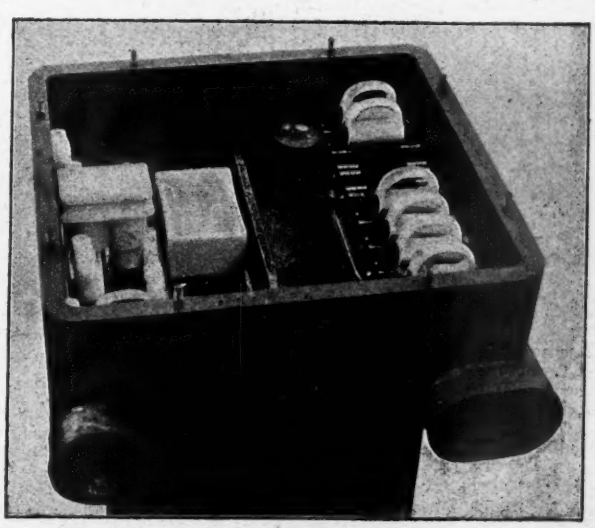


Fig. 2.

introduction of a dangerous type of apparatus. In some instances, compactness is considered before all other details, here again the design falling considerably short of the ideal by reason of the sacrifices made; and last, but not least, many designers give such prominence to cheapness of production that much which could be otherwise gained is lost.

However, several years' experience have borne good fruit, in that manufacturers have not only learned what transformers should *not*

be, but are, by reason of their experiments and experience, well able to indicate the lines on which sound methods of construction should run. Apart from their own work, by a general observation of the results of the labours of others, they are taught to seek the "happy medium" between cheapness and electrical efficiency.

The temptation, however great, to sacrifice all to cheap construction, must be kept well in the background, every effort being made to place on the market a transformer at a reasonable price yielding a reasonable profit. There are, of course, restrictions to such conditions, restrictions which, by the varying prices of material, come more or less strictly into force.

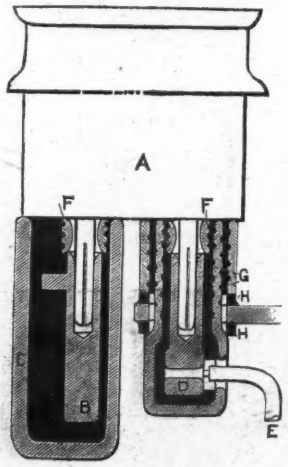
As regards the mechanical details of transformer design, experience has shown that, before everything else, the safety of the electrical staff must be considered. This holds good with transformers in street pits as well as in sub-stations, each case being met, where possible, with a similar design of apparatus. It is here, more than anywhere perhaps, that the manufacturer is handicapped by the consulting engineer, who specifies designs which may not coincide in any way with the goods supplied by him. It is in such circumstances that the manufacturer must take the "bull by the horns," and design an article which will meet all reasonable requirements, at the same time being arranged with a certain degree of flexibility for a particular departure.

With a long standing experience and reputation in the construction of transformers, Messrs. Ferranti have had exceptional opportunities of improving their design and placing on the market an apparatus which will meet the requirements of most engineers.

A glance at some of their standard types will make the statement more evident. A general idea of the transformer proper can be obtained from fig. 1, which is a photograph of the apparatus ready for lowering into a street tank.

It will be seen that the arrangement is complete in itself, all high and low tension connections being brought to the top of the apparatus, where they terminate in contacts suitable for plug and fuse connections. For street work it is obvious that this method is of great advantage in the removal of a transformer. The tank illustrated is made in one size only (to receive a 50-KW. transformer) for sinking under the pavement, there being no further necessity for disturbing it when once buried in the ground. It is then ready to receive transformers ranging in size from 5 to 50 KW. On either side of the tank are arranged the H. and L.T. connections, special attention being given in the former to ensure absolute safety to the working staff, as shown in fig. 3.

A single-pole oil-break fuse protects the primary winding, connections to the transformer on the other conductor being effected by



A, Ferranti oil-break fuse; B, Plug socket on ring main; C, Porcelain box containing same; D, Plug socket for transformer; E, H.T. connection to transformer; F, Porcelain ferrule covering sockets; G, Porcelain insulation for terminals; H, Rubber washers permitting sockets to accommodate themselves to the plugs.

FIG. 3.

means of a plug. Similar plugs are used to connect together the H.T. cables entering from either side, this arrangement enabling the transformer to be removed without interrupting the primary main.

On the opposite side of the tank, quite distinct from the high pressure terminals, are the low pressure contacts. These are arranged for the reception of four secondary cables, two at each side of the tank. Both high and low tension cables enter the tank by water-tight glands, to ensure the terminals from contact with any moisture which may accumulate in the pit, but should the interior of the pit become damp in any way, this moisture will be absorbed by the chloride of calcium contained in a tray placed on the top of the transformer.

The photograph, fig. 2, shows the general appearance of the transformer lowered into the tank and connected to both primary and secondary cables with plugs and fuses. A Cardew earthing device for the secondary winding may also be plainly seen.

Without any alteration to the transformer winding or core, but by the interchange of terminal and base plates, an arrangement for central station use, similar to fig. 4, can be made up. In this case the connections are provided for in the lower part of the transformer, primary and secondary being kept distinct by arranging them at opposite sides of the transformer. Water-tight glands are again used, and the ends of the cable are sealed inside the contact wells to prevent moisture creeping up the insulation. The arrange-

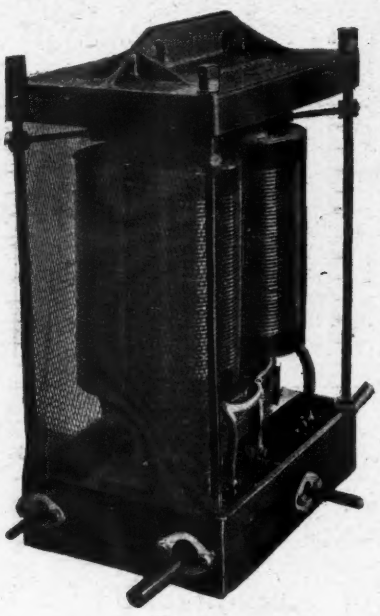


FIG. 4.

ment of this transformer is well adapted for use in central stations where the air is warm and dry, or in sub-stations where a similar state of things prevails. The photograph illustrates the secondary connections grouped for the three-wire system.

Yet another adaptation of this transformer is possible without in any way altering the core or winding. This is illustrated by figs. 5 and 6, where views of the sub-station tank and transformer are shown.

It will be seen that the transformer remains the same as in other illustrations, while the upper plate is arranged to form the cover to the tank, the terminals being placed in the circular box which surmounts the whole. The tank itself is constructed to be absolutely

FIG. 5.

watertight, the only joint being made between machined surfaces packed with suitable jointing. The advantage of this arrangement is felt where there is a liability for sub-stations to become flooded.

The circular space above the transformer allows of the introduction of both high and low tension cables through water-tight glands, the high tension terminals being so fitted that it is impossible to touch them accidentally. Oil break fuses can be used for connecting to the primary winding if required without alteration to the outer case.

On the secondary side the connections can be grouped for either (*a*) three-wire systems; (*b*) two-wire systems; (*c*) two-wire systems, 100 or 200 as required, the whole of the changes being possible on one set of terminals.

The cover of the box screws down on to suitable jointing, the eye bolts providing for the slinging of the arrangement.

The engineer whose requirements could not be met by any of the above designs, must be, indeed, hard to please, as most of the possibilities of transformer practice are covered by these examples. There are, however, instances where the engineer is the victim of circumstances which necessitate some adaptation of a standard pattern, though this may be much against his will. In such cases

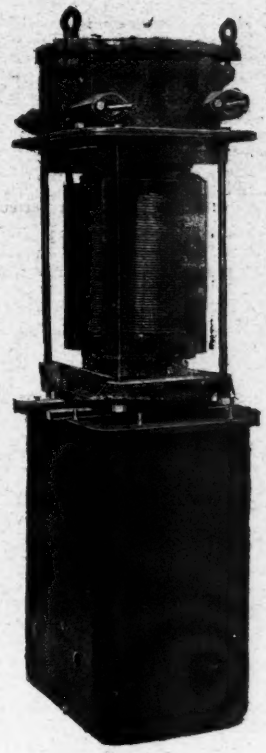


Fig. 6.

the flexibility possible with Messrs. Ferranti's designs enables them to accommodate these isolated instances to the satisfaction of any engineer.

In conclusion, it must be remarked that every reasonable attempt has been made to bring the transformer to that degree of perfection which existing circumstances will allow. The best material is used, the most efficient electrical design adopted, and every attention is paid to mechanical construction, while no pains have been spared to ensure absolute safety.

The results are in every way typical of the labours expended, in that almost every reasonable requirement is met, and the work of Messrs. Ferranti in the direction of transformers will enable them to maintain the leading position they took as pioneers of alternating current working.

INSTITUTION OF ELECTRICAL ENGINEERS (GLASGOW SECTION).

A METHOD OF COMPENSATING VOLTMETERS FOR THE VOLTAGE DROP IN LONG FEEDERS.

By Michael B. Field, A.M.I.C.E.

Paper read February 13th, 1901.

(*Continued from page* 386.)

Fig. 6 may be considered as equivalent to fig. 5 if we consider the potential differences called into play by the drop across R_1 and R_1' as replaced by opposing E.M.Fs. If now the ratio arms of the Wheatstone's bridge be slightly out of balance, it is clear that the current through the voltmeter will be proportional to the expression $\{v_1 - v_1 - (\alpha\, c_1\, R_1 + \beta\, c_1'\, R_1')\}$, where α and β are numerics the value of which may be adjusted as desired by merely altering the resistance of the ratio arms. If, therefore, they be adjusted so that $\alpha\, R_1$ equals the resistance of the outer, and $\beta\, R_1'$ the resistance of the neutral, it is clear the voltmeter indications will be proportional to the voltage obtaining at the far end between outer and neutral.

With the device just described it is of the utmost importance to select as sensitive a voltmeter as possible in order to minimise the losses which take place in the shunt resistances. In the latter portion of this communication this is shown to be the case, the following result being arrived at analytically:—

If the method be applied to a three-wire system with 400 volts between outers, and if the series resistances in the outer and neutral mains are as large as is at all practicable to make them (*e.g.*, the drop of volts along $R_1 = 0{\cdot}2$ volts and along $R_1' = 0{\cdot}4$ volts with an average full load (the drop along the resistance R_1' may be taken higher than along R_1 since the current in the former case is much

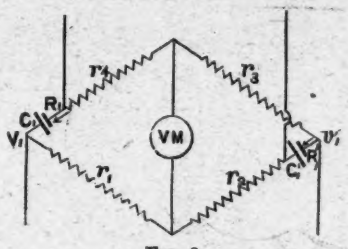


Fig. 6.

less than in the latter, so that a larger drop does not necessarily imply a large loss of power), and if the voltmeter required $\frac{1}{100}$th ampere to give the full scale deflection, then the resistance of $(r_1 + r_2)$ and $(r_3 + r_4)$ could not well be more than 890 ohms. This would involve in them alone a continuous loss of nearly 90 watts. Instruments of the dead-beat suspended coil d'Arsonval type made up in switchboard form, with a needle swinging in a horizontal plane as in a Kelvin low-tension electrostatic voltmeter, would therefore be best for this purpose, for with suspended coil voltmeters of this description not only can the values of the resistances $(r_1 + r_2)$ and $(r_3 + r_4)$ be increased to 3,000 or 4,000 ohms, but the maximum drop of volts across R_1 and R_1' may also be greatly reduced.

When employing this method for determining the average of several feeding-point voltages, a multiple contact switch as shown in fig. 2 is necessary. It is also necessary to shunt the voltmeter by means of the resistance s, but the resistance ρ of the various connecting wires may be made as low as is convenient, since the resistances r_1, r_2, r_3, r_4 will themselves prevent any appreciable interchange of current between the various feeder circuits.

Fig 7 shows a particular case where the voltage at the end of a set of three-wire feeders may be simply arrived at. The figure is a

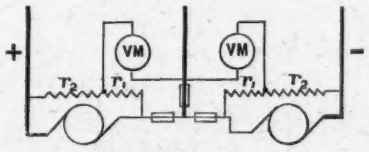


Fig. 7.

sufficient explanation of itself. It is, however, clear that this case is rarely applicable in practice.

In Heap's Patent 8,348 of 1898, instruments of the Weston type are described for use in three-wire circuits, where the moving member has two distinct coils and four terminals as shown in fig. 8.

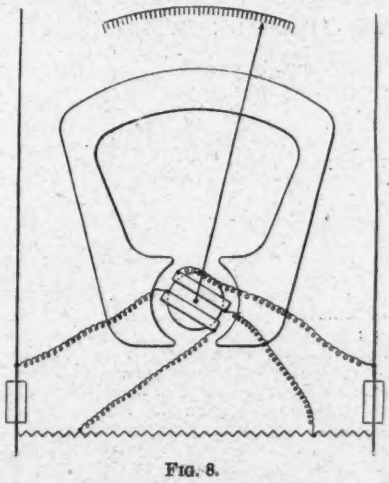


Fig. 8.

The great disadvantage of this arrangement is, of course, the difficulty of insulating the coils on the movable member from each other, the difference of potential being the full voltage between outer and neutral wire.

A further device is described, as shown in fig. 9, with reference

to instruments depending on the attraction of a small piece of iron. If these instruments be used at all, they may quite as readily be compounded with a few turns in series with the outer and neutral mains in accordance with the original scheme of Dr. Hopkinson. In any case, the device of Heap described above possesses the dis-

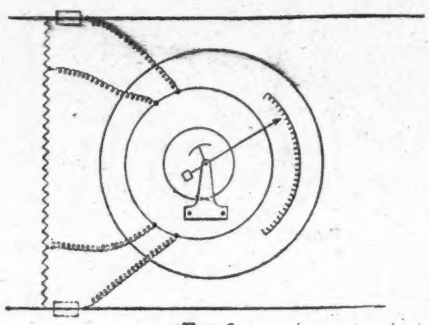


Fig. 9.

advantage that unless a large drop be allowed in the inserted resistances in the mains, the available voltage across the terminals of the voltmeter is altogether insufficient. For example, on a 250-volt circuit, if the series resistance caused an added drop of, say, 2 per cent. of the feeder drop, the available difference of potential for working the voltmeter would be only about 2·5 volts. With an instrument of the above type to be actuated by only 2·5 volts, a comparatively large current would be necessary, causing a relatively large watt-loss in the whole arrangement.

Case C.—This case, viz., the compensation for the ohmic and inductive drop in long alternate current transmission lines, has been very ingeniously handled by Mershon. As already intimated, fig. 3 gives the pith of Mershon's arrangement, but in his American patents a considerable number of very pretty modifications are shown; but all of these, as he is careful to point out, depend upon the employment of potential or current transformers, or both.

The following method, therefore, which is quite independent of all transformers, not even necessitating one for the voltmeter, may be of interest.

In this instance not only must an extra resistance be inserted in the line, but similarly an extra self-induction, unless, indeed, a portion, say a $\frac{1}{300}$th part of the resistance and self-induction of the line itself, be employed for the purpose by running back a pilot-wire to the station from a point on the line situated at a distance from the power station equal to $(\frac{1}{300})$th part of the whole length of the line.

To fix our ideas, let us consider a specific case where the line voltage is 30,000 volts, the line being 50 miles from end to end. At the station a 100-volt multicellular electrostatic voltmeter of the Kelvin type is employed, and connected as shown in fig. 10. It would, of

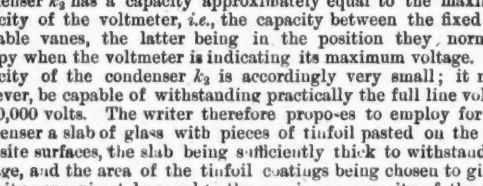


Fig. 10.

course, have to be thoroughly insulated from earth. k_1 and k_2 are condensers replacing the resistances r_1 and r_2 shown in fig. 1. The condenser k_2 has a capacity approximately equal to the maximum capacity of the voltmeter, *i.e.*, the capacity between the fixed and movable vanes, the latter being in the position they normally occupy when the voltmeter is indicating its maximum voltage. The capacity of the condenser k_2 is accordingly very small; it must, however, be capable of withstanding practically the full line voltage of 30,000 volts. The writer therefore proposes to employ for this condenser a slab of glass with pieces of tinfoil pasted on the two opposite surfaces, the slab being sufficiently thick to withstand the voltage, and the area of the tinfoil coatings being chosen to give a capacity approximately equal to the maximum capacity of the voltmeter. To prevent leakage and condensation on the edges of the slab, the whole might advantageously be immersed in a bath of special oil or be imbedded in a block of paraffin wax or other suitable dielectric.

The condenser k_1 must have a capacity nearly 300 times as great as that of k_2; since, however, the voltage across the former will be of the order of 100 volts, it can readily be constructed in the usual way of sheets of tinfoil and mica, and will not be an expensive matter. It is important that the ratio of the capacities of k_1: k_2 be maintained exactly, but it is not of any importance that the capacity of k_2 shall bear any very exact ratio to that of the voltmeter. Thus the voltmeter, if deranged, might be replaced by another of the same pattern, and the latter would indicate correctly. If a portion of the line itself be utilised, instead of inserting extra resistance and inductance a pilot-wire must be run back from a point one-third of a mile distant from the power house. This wire must be protected, of course, from the inductive action of the current in the line in a manner explained later on. One advantage in utilising a portion of the feeder itself instead of inserting extra resistances, &c., which may of course be done in this or any of the foregoing cases, is that no error is produced by a change of resistance of the line due to changes of atmospheric temperature.

We thus have a simple and inexpensive arrangement whereby a 100-volt electrostatic voltmeter may be arranged to measure directly the potential at the far end of a 30,000-volt line, the voltmeter being compensated for both ohmic and inductive effects of the line itself.

It is obvious that similar arrangements may be applied to many such useful purposes; *e.g.*, in the last case the voltmeter might be arranged to compensate not only for the line drop, but also for the drop due to both copper resistance and magnetic leakage in the transformer at the far end, and thus indicate the voltage at the low tension terminals of the transformer irrespective of what kind of load may be connected to the same, *i.e.*, one possessing self-induction, capacity or anything else.

The drop in the transformer might be exactly imitated by inserting in series in the circuit (now containing a perfect transformer with no drop), a definite self-induction and resistance. These might then be considered as forming part of the transmission line, and therefore by adjusting h_1, k_2, and the inserted resistance and self-induction, or possibly the position at which the pilot-wire is connected, the drop due to the extra resistance and self-induction, *i.e.*, the drop in the transformer at the far end of the line, may also be compensated for.

(*To be concluded.*)

INSTITUTION OF ELECTRICAL ENGINEERS.

THE ELECTRICAL POWER BILLS OF 1900: BEFORE AND AFTER.

By Wm. L. Madgen, Member.

(*Abstract of paper read February 21st*, 1901.)

(*Concluded from page* 388.)

I shall not attempt to follow the more technical aspects of the subject just now, as they afford scope for many papers, and certainly for more discussion than you can give to them this evening; but it may be well to summarise the points for and against the old system and the new, *i.e.*, the supply from small local stations and the supply from main power stations:—

Supply over comprehensive areas from main power stations in selected positions.

ADVANTAGES:—

1. Comparatively large field for development.
2. High load factor obtainable, all the plant being used to the best advantage.
3. Cost of fuel and handling can be reduced to a minimum, as the power station can be located where fuel is cheapest, fuel handling is most economical, and water is available for condensing.
4. Low running costs, management expenses and maintenance per unit sold, as the result of a very large and regular output.
5. The low cost of plant per kilowatt installed, and the increased economy in running with very large sets.
6. Low rents, rates and taxes; the difference between town and country.
7. Economical provisions for extensions to plant and buildings.
8. Low costs and charges for electrical energy for all purposes possible in consequence of above advantages.
9. Removal of the power station with its chimneys, &c., outside the residential district.

DISADVANTAGES from point of view of local authority:—

1. The transmission mains must pass through their area whether supply be taken or not.
2. Sentimental preference for complete independent plant of their own.

Supply in small local areas from separate stations.

ADVANTAGES:—

DISADVANTAGES:—

1. Small field for development.
2. Relatively low load factor.
3. Cost of fuel, handling it, and water supply depend on immediate local conditions, favourable or unfavourable.
4. High running costs, management expenses, and maintenance, the costs per unit sold being generally higher the smaller the station.
5. High relative cost of machinery per kilowatt installed, and lower economy in running.
6. Rents, rates and taxes relatively higher.
7. The extension of buildings is frequently very expensive, owing to disturbance and other difficulties incidental to town sites.
8. High charges for electrical energy for all purposes as result of these disadvantages.

When the early history of the electrical industry comes to be written, the part played by the local authorities in their strenuous opposition to the Power Bills will be a record of reproach to them.

For the purposes of this opposition there was a conference of local authorities in Manchester in January, and a meeting of the Association of Municipal Corporations in May. The object of the first meeting was to prevent the second reading, and that of the second to influence the decision of the Parliamentary Committee.

The methods adopted by those who endeavoured to wreck the Power Bills were strongly condemned in the course of the second reading * debate, and the President of the Board of Trade found it necessary to repudiate a garbled report which had been circulated as to his remarks upon the Bill for the Warsop project in the previous session.

Everyone interested in the welfare of the industry should read and think over that debate. True, the Bills were read a second time and committed, but what a curious light is thrown by the discussion upon the difficulties with which we have to contend!

Perhaps there is time to mention two examples Mr. Ritchie said, ". . . . It is true, I think, that the electrical enterprise of this country is in an exceedingly backward condition; it is inferior with regard to light, and certainly with regard to the conveyance of power, to many European countries, and it is greatly inferior to North America and Canada. It cannot be doubted that there is a great demand for something to be done. At present electric light matters are governed largely by the legislation of 1882, and it has been said that this Bill is largely in opposition to many of the enactments in the Act of 1882. If no other charge or argument could be brought against this proposal, the argument of the opponents to this Bill would indeed be weak. It must be remembered that it was the Act of 1882 which more than anything else had delayed and hampered the development of electrical supply, and in so far as this Bill departs from that Act, I think its departure is amply justified by the condition of things at present existing in the electrical world."

Here we have a member of one of the strongest Governments of modern times, the Minister entrusted with legislation affecting the trades of the country, who has realised the extent and cause of our backward condition in relation to a great industry, and ingenuously confessing that during five long years of office one of the main causes of the trouble has remained effective upon the Statute Book.

Sir William Harcourt said, ". . . . I do not altogether share my on.† friend's objections to great enterprises being carried on through private sources. That was a question which occupied 50 or 60 years ago the attention of this country, and that was at the time of the commencement of the great railway interest. That question was decided by the wisdom of the great statesman Sir Robert Peel. We know that Sir Robert Peel was much attacked at that time for throwing the railway enterprise of this country into private hands, and not adopting the system so largely followed on the Continent. I look forward to this question of electricity and electric supply as the great question of the future, and it is from that point of view that I wish to refer to the subject. If this company is prepared upon proper conditions to supply electricity to any part of the country, I am not opposed to that. No man can say to day what part electricity may not play in the industry of the country, and that is a point which the House of Commons should keep in view. But what are the conditions which ought to be imposed? What was the policy which was pursued with regard to the railway companies? Parliament did not leave it altogether to particular promoters of Bills; Parliament did not leave it to the discretion of individual committees. They placed the whole of that great enterprise, upon which more than a 1,000 millions of private money has been expended, greatly to the benefit of the country—a sum larger than the National Debt, and now paying interest at least of 4 per cent., and one of the greatest investments for the savings of the country—under general legislation. I think that a model which we ought to follow in this instance. But what was the method which Parliament in those days adopted in dealing with the railways? They did not allow particular promoters to take their chance in individual committees. They placed the whole of that great enterprise, as I have said, under general legislation. . . ."

This statement of Sir William Harcourt goes to justify the charge that the Legislature has neglected an industry the importance of which he describes in suitable terms, and it also leads us to the economic aspect of the question. Comparisons have been drawn between the benefits first derived by every class of our community from the applications of steam power and of railways, and those which have accrued to other nations in larger measure than to ourselves from the uses of electrical energy. The United Kingdom itself has not yet lost any material part of its natural advantages for the manufacture of engineering material or of scope for their employment. In what way has destructive legislation acted so as to place us in the position of inferiority we are reproached with to-day?

It has, among other things tended to destroy cumulative investment effect. Savings out of the profits of a business tend to go back as an additional investment into that business or some department of trade allied with it. Part of the profits derived from railway enterprise undoubtedly went in again, and, attracting new capital to it, provided means for building new lines and for equipping new rolling mills, foundries, engine works and other undertakings which have provided employment for thousands of our fellow-countrymen. No influence has done so much during the past 100 years to stimulate enterprise, to encourage commerce, and to develop the resources of any country.

In our own time legislation has not only deprived the great mass of the people of the direct benefits of electrical science, but it has made much of what little has been done indistinguishable to the investor from local government loans for drainage, refuse destructors, slaughter-houses, and other purposes most necessary in themselves, but somewhat in the back-yard of civilisation.

It may be replied that Sunderland, for instance, has just declared a profit out of its municipal tramways, but what advantage has this been to anyone? The fares have been substantially the same as would have been charged by private enterprise or the amount would not have been earned. The local rates we may be sure will not go down, and if they are a trifle lower than they otherwise would have been, those to benefit most will be the railway company and other large ratepayers who have contributed least to the tramway revenue.

The banks, insurance companies, and such institutions which provide much of the local government loan capital will get their 3½ per cent., and part of it may be re-invested in colourless loans elsewhere, but of that great encouraging influence towards the growth of healthy industry which I have imperfectly described as the cumulative investment effect there will be little or nothing.

And the money for the purpose has been deflected elsewhere. The subject is a complicated one, and it may not be in place to follow it here, but it is a significant fact that, *exclusive* of foreign loans, the yearly increase of capital from this country invested abroad averages at present about £30,000,000. One tendency of this has been to set more people to work abroad instead of at home, and to increase the competition against home industries.

In the interests of which class of the community the enactments I have referred to were passed and have been adminstered by the various authorities it is difficult to say. They have not benefited the general public; the complaint made on their behalf is that they are debarred from the advantages of electricity; and least of all have they benefited the working man, who finds that while the electric light and comprehensive electric tramways are not for him, hundreds of thousands of pounds' worth of foreign-made plant and accessories are landed on our shores.

The future of the electrical profession is so interwoven with social questions that we cannot escape their consideration. Mr. Balfour has said, "I believe that electrical traction is going to play a far larger part in the solution of this difficulty"—the housing of the working classes—"than any of the strange schemes I have analysed"; Mr. Lough that "It has been agreed by everybody that the chief means of improving housing accommodation is to spread out the city and destroy congestion, and it is agreed that there is no way of doing this effectually except by providing better facilities for traffic."

No one can question the advantages of improved traffic facilities, but if the direction morning and evening is to and from a congested trade centre, the problem is only half solved. It is to electric power distribution on a sufficiently comprehensive scale to adapt the country districts to manufacturing purposes, in company with inter-urban connection by means of electric traction, that we must look for the greatest agency in ameliorating the conditions of the working classes in all their surroundings.

It can scarcely be asked what has all this to do with the Institution of Electrical Engineers, for we have seen that the community is conscious of the backwardness of our work, and faced by social phenomena such as those to which I have referred, we are called upon to perform our part in counteracting them. Electrical science is ripe for the occasion, and it, therefore, appears to be our duty and to our interest to convince the Legislature as to the means it should take to enable us to carry on the services assigned to us.

As some technical objection might possibly be raised to any action we may take in this direction, we shall find, on consulting the Memorandum and Articles of Association, which describe the scope and general organisation of the Institution, that (among allied objects) it was established "*To promote the general advancement of electrical and telegraphic science and its applications. . . .*" (*Sec. 3 B*), and "*To do all such other lawful things as are incidental or conducive to the attainment of the above objects*" (*Sec. 3 D*).

Article 53 says that "*It shall be the duty of the Council to adopt all due means for the advancement of the Institution; to provide for properly conducting its business in all cases of emergency. . . .*"; and a preceding *Article* 49 provides that ". . . . *The Council may appoint Committees chosen from their own body, and Committees for special purposes consisting of Members of Council and Members, Associate Members, or Associates of the Institution and others, with such powers as the Council may prescribe.*"

Thus the terms of our Constitution not only authorise action being taken, but they also appear to intimate the course to be followed in dealing with any obstacles with which we may have to contend, and I trust that the discussion will give the Council an indication as to the desirability of appointing a special committee, as provided by *Article* 49, to consider what steps should be taken to remove the restrictions upon us, some of the effects of which I have endeavoured to describe.

WIRELESS TELEGRAPHY.

On Friday, March 1st, the London branch of the Postal Telegraph Clerks' Association held a Grande Soirée Dansante and Bohemian Concert in the Holborn Town Hall. The function was of a most brilliant and successful character. An excellent concert, under the direction of Mr. George Costello, took place in the lower hall, and

* See "Parliamentary Debates," No. 2, Vol. lxxix. (page 1,374 and following), published by Wyman & Sons, Limited, Fetter Lane. Price 1s. 3d.

† Mr. Broadhurst.

ran concurrently with the dancing in the large hall. Two excellent pianos were lent by the Civil Service Musical Instrument Association, and the orchestra was under the direction of Mr. Arthur Crudge.

At nine o'clock the dancing was suspended in the large hall in order that Prof. Fleming, F.R.S., should give a short address on the Marconi wireless telegraph. The lecture was illustrated by a beautiful and specially-prepared series of lantern slides. Prof. Fleming, in opening his address, paid a tribute to the many workers in the field of telegraphic science who had done so much to develop the systems of wire telegraphy now in use, among whom were many Post Office officials. He said Marconi's system was not at all likely to supersede the systems of wire telegraphy now in use for inland communication, and by which so many of his audience gained their livelihood. The object of his lecture was to explain the underlying principles of Mr. Marconi's system. The system was a development upon practical lines of the discovery made in Branly's tube. He did not desire to give too many dry scientific details, but must enter upon some short explanation of the ether, what it was, and what we knew of its manifestations. He did this lucidly and clearly, and then went on to explain Hertz's discovery that an electric spark caused a splash, as it were, in the ether sea, and spread out ripples as water would be rippled by a splash. Mr. Marconi's improved form of Branly's tube was then explained, and the extra sensitiveness given to it by the attached arm. This tube or "coherer" was designed to catch a record of the ripples from the ether splash and by attached apparatus convert them into readable Morse signals. Mr. Marconi's first experiments were made upon his father's estate near Bologna, in Italy, and he was so far successful that coming to England he was able, in 1897, to set up an apparatus from Bournemouth to Alum Bay, a distance of 16 miles, and across this distance to get good and most useful results. The Professor then went on to explain how, by a series of inventions and experiments, Mr. Marconi had succeeded in working with poles of lesser and lesser height, and said that Mr. Marconi had recently told him that he had been able to get some startling results over considerable distances by using merely a zinc cylinder 4 ft. in height enclosed in the working room. This statement was received with applause. Prof. Fleming then described in detail the experiments between the Lizard and St. Catherine's Point, illustrating his remarks by photographic slides representing the poles at either place. Some of the details of the improved tubes used in the transmitting apparatus he was unable to explain, as Mr. Marconi wished them to be kept secret for the present. The successful signals from St. Catherine's Point to the Lizard were interruptions occurred in one cable. The Marconi system was vastly superior, much cheaper, and infinitely more certain. He referred to the case of the *Princess Clementine* running ashore and her communication with Ostend, by which means a tug was sent out immediately to her assistance. It had frequently been debated whether Marconi had done anything new. He admitted that the system was based on the discoveries and researches of Branly and Hertz, but Marconi had applied these discoveries to a practical use and worked out the elaborate details of a complete system. In that he was entitled to credit, and had undoubtedly added something new.

On the motion of Mr. C. H. Garland, a hearty vote of thanks was accorded to Prof. Fleming for his able and interesting address.

The Marconi apparatus had been fitted up in the Hall and most successful communication was made. The speed attained was about 15 words per minute, and the marks were perfect. Interesting records were on view of messages received from travelling ships and other sources, and some of those which had passed over the 200 miles separating St. Catherine's from the Lizard were also on show. There was a consensus of opinion among the large, and mostly expert, audience that the experiments were highly successful and of a most interesting character. This is the first occasion upon which a purely postal audience have been able to see the Marconi apparatus in actual use.

A NEW FEEDER SWITCHBOARD AT NEWINGTON ELECTRICITY WORKS.

A FEEDER switchboard has just been supplied and erected at the Newington electricity supply station by the General Electric Company, Limited, of which, on account of the special design of the supporting framework, and its flexibility as regards erection, extension, or adaptation to any form of board, a description will be of interest.

A few remarks may be made as to the causes which led to its erection. Since it was opened in 1899, the Newington electricity station has installed additional plant, and certain extensions have been made in the private lighting, necessitating three new feeders. It was recognised that the large station switchboard standing in the gallery, manufactured by the General Electric Company (and

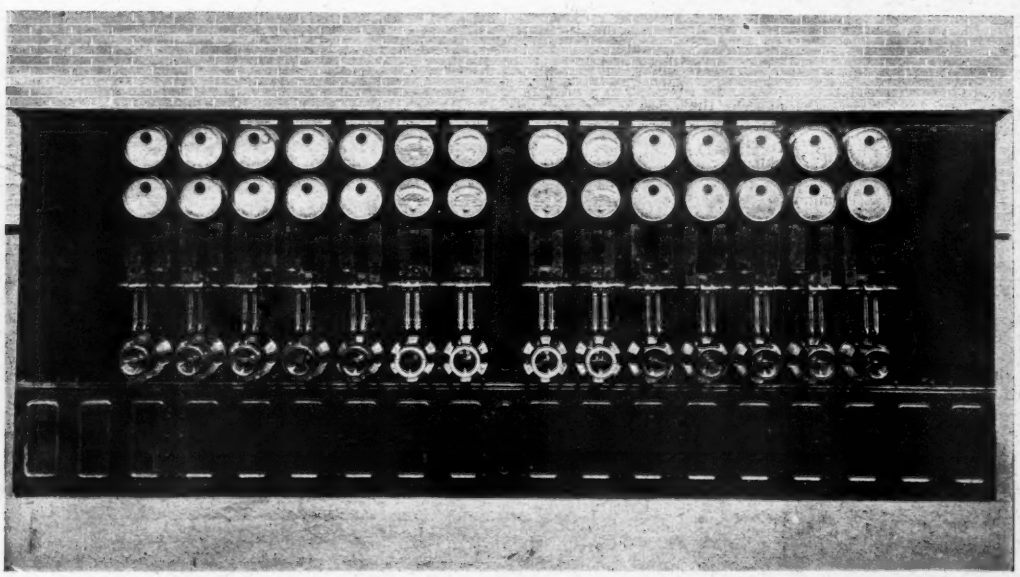


FIG. 1.

obtained on the first day of the reign of King Edward VII.—a notable coincidence. A description was given of experiments in "tuning," which made it possible to receive two or three distinct messages on one mast, and some striking maps were exhibited showing how simultaneous communication was established between St. Catherine's, Portland, Poole and the Lizard without the messages interrupting each other. This opened out a very extended horizon to the Marconi system, and removed one of the most frequently urged objections to it. There was, said the Professor, no fear of the system replacing the present wire systems. There was a vast field for it quite apart from that. It was an ideal system for communication between lightships and the shore and for signalling from passing ships to the shore stations. It worked without interruption or failure between the South Foreland and the East Goodwin lightship for two years, and showed a vast superiority over the attempts made to connect lightships by cable with the mainland. Much money had been spent on cable connection, with the result that in 2½ years 27

included in the description of the station in our issue of June 23rd, 1899) was not capable of accommodating all the necessary new panels, owing to the fact that it already nearly filled the gallery. It was, therefore, decided to remove the five positive and negative feeder panels to the floor at the other end of the engine house, and to erect in their place the panels for the new plant. The whole of this work was carried out by the original makers of the switchboard, and it comprised (1) one positive and one negative panel for a 400-KW. set, containing one B.T.H. maximum automatic cut-out, one ammeter, one single-pole switch, and one minimum automatic cut-out, one S.P. fuse, and one double shunt rheostat, respectively; (2) one balancer panel containing two fuses, two centre zero Weston ammeters, one starting rheostat, two knife switches, two shunt rheostats, and two field switches; and (3) one booster panel containing two D.P. fuses, one Weston ammeter, one centre-zero ditto, one Weston voltmeter, two D.P. switches, one starting rheostat, two shunt rheostats, and two field switches. The

shunt rheostat on the large machine panel is deserving of special notice in that it comprises one large-step and one small-step regulator on the potentiometer principle.

In addition, one spare 400-kw. panel was supplied, and the old knife switches were replaced by the new and improved "Peel" spring knife switches, while minimum automatic cut-outs were added to all the old machine panels. The solid bus bars at the back of the board were replaced by new ones consisting of three copper strips each, taped together, and these have been extended to the end of the gallery where the middle wire bar drops straight down, whilst the positive and negative, after traversing the station watt-hour meters, are carried bare on insulators to the end of the engine house—some 60 ft. Here they drop down to the new feeder board, to which they are connected by bare copper arches.

The new board comprises the five old positive and negative feeder panels arranged from the centre outwards, three additional panels on each side, and one spare panel on each side. Each panel contains one feeder ammeter, calibrated in volts after allowing for the drop for the current indicated, one voltmeter indicating station volts, one plug fuse-block with two fuses, one knife switch, and one regulator for back E.M.F. cells. The instruments on the new panels are of the Weston type. The new panels also have screw plugs instead of fitted plugs, and the fuses are covered with micanite shields instead of mica shields. All the switches on the old panels have been replaced by "Peel" switches to match those on the new panels, and these are similar in pattern to those on the station switchboard, having double contacts and carbon breaks. The accompanying views showing (fig. 1) the front, and (fig. 2) the end of the board will give an idea of the way in which the framework is built up. In devising this design the object aimed at by

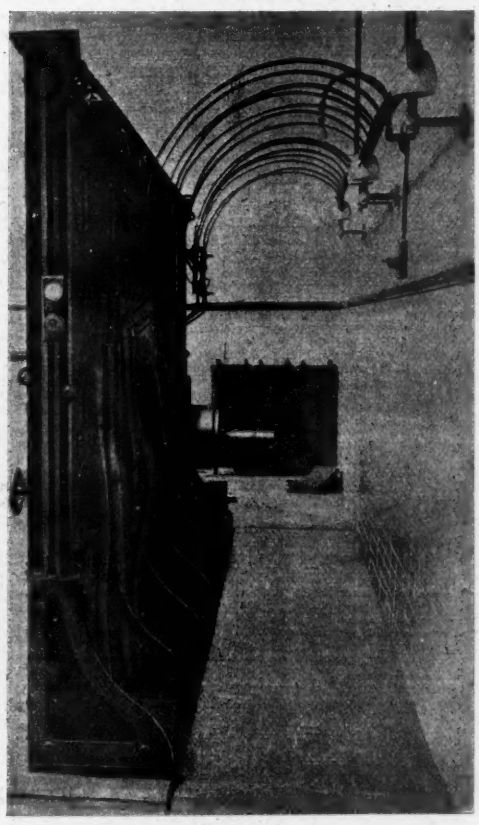


Fig. 2.

the General Electric Company was to have a standard series of parts which could be put together with a minimum of labour, combining great strength, flexibility, and unlimited possibilities of extension.

The parts are all of cast-iron and comprise for one panel a base, two side web brackets, two side frames, one apron, and one top frame. Of course, the number of brackets and side frames are always one more than the number of panels. The base is cast with a long hole in the centre for entering cables, and five bosses with holes for coach screws for screwing to the floor. The brackets are bolted to the base through their flanges and support the apron in like manner; the side frames, which have a flange top and bottom are bolted at the bottom to the top of the bracket, and at the top to the top frame, which they support. The side frames have also bosses with holes half way up and at the top for bolting up to the next one, and so on *ad lib.* The top frame is cast with three rectangular holes for lightness, separated by two webs. It is in section somewhat like a T, into one angle of which the top of the panel fits, whilst the bottom rests in an angle or ledge cast in the apron. The panels are bolted top and bottom against these angles in the usual manner. With various standard heights of panels the number of panels of any width and height which can be erected is quite unlimited, and after they are bolted on, the edges are finished off with a neat moulding and the whole painted a uniform colour. The whole of the work was done by the General Electric Company, and the alterations were accomplished without shutting down the plant or depriving anyone of the light.

ELECTRIC SHOCK ACCIDENTS: THEIR PREVENTION AND REMEDY.

To guard against contingencies, Mr. S. B. Cottrell, engineer and general manager of the Liverpool Overhead Railway Company, has had a list of "Precautionary Instructions" printed in leaflet form and circulated among the employés of the company. It reads as follows:—

Precautionary Instructions in Relation to the Avoidance of, and for the Treatment of Sufferers by, Accidental Shock from Electrical Current.

1. If ordinary precaution is observed in handling the electrical cables, wires, or apparatus, no danger need be apprehended; but where indifference to well-known restrictions, or negligence in any form, is allowed to prevail, serious consequences may ensue, not only to the individual guilty of such negligence, but to others who may be associated with him in the discharge of his duty. Regard any apparatus with which you may have to deal as capable of affording a shock, and adopt precautions accordingly.

2. No person should be entrusted with the performance of a duty until he is perfectly competent to deal with it.

3. When it is necessary for regulation or other purposes to touch parts of such apparatus when the current is active, the individual should be careful that his entire person is insulated from the earth, and from anything, other than an insulating medium, which connects with the earth. This may be best achieved by standing on an india-rubber mat. On no account should he touch parts of the machinery, cables, or apparatus with both hands at the same time, unless his hands are protected by sound india-rubber gloves. Shoes with india-rubber soles may be worn as an extra precaution, but the wearer must never rely upon them for insulation. Dynamo room men should keep such shoes in the dynamo room, and not wear them indiscriminately in and out of doors. The soles should be examined daily in order to ascertain that they are sound and dry.

4. The inspector and foreman of each depôt will be held individually responsible that a sufficient supply of india-rubber gloves are kept on hand to replace broken ones, and that one or more pairs (according to the magnitude and importance of the installation) are retained in a closet provided specially for the purpose (and marked "India-rubber Gloves"), so as to be readily accessible at any time.

5. Workmen are required, after using the gloves, to return them to the officer in charge of the dynamo or distributing room, and that officer will be held responsible that all gloves issued to workmen are returned to the closet or otherwise accounted for by an entry in the diary.

6. Should a lamp require attention during the time the current is flowing, the lamp is to be switched out of circuit before being touched, by the switch at the base of the lamp pillar, where such is provided; otherwise by the switch on the lamp, which it must be borne in mind, does not insulate the lamp.

7. In cases of accident, where a man has become paralysed by the current, and is unable to extricate himself:—

(*a*) The first effort should be to switch off the current.

(*b*) Failing the power to do this, to divert the current from the sufferer.

8. The first instruction is easily effected where the accident arises within ready reach of the dynamo, distributing room, or switch.

9. The second instruction requires careful handling on the part of the rescuer. He has to bear in mind that if he touches the sufferer with his naked hands—even by his clothing, if damp from rain or the perspiration of his body—he may be placing himself in the same dangerous position as he whom he desires to rescue.

10. It is necessary that he should keep himself insulated from the cable or apparatus, and from the sufferer, as well as from the earth.

11. Time is of the utmost importance, and will probably not admit of running for gloves or india-rubber mats. An instant of time may, if judiciously employed, suffice to release the sufferer, and any dry article of clothing may serve as an insulator for that short period.

12. If a piece of wire of sufficient capacity—an iron rod or any form of conductor—is at hand, the rescuer should, first, connect one end of the wire or rod to earth, and failing a better means, divest himself of his jacket or coat and use it to insulate his hands from the other portion of the wire or bar and the cable whilst he attaches it to, or places it in contact with, the cable (or whatever may be the source from which the current is passing into the sufferer). The attachment should be as near to that part which is in contact with the sufferer as is possible. This may divert the current to the earth and release the sufferer.

13. Whether it does so or not, the rescuer should, with continued caution, proceed to remove him from the position in which he is placed. He must insulate his own person by standing on a dry board, dry clothing, a bundle of dry straw, hay, &c. He must protect his hands by interposing as many thicknesses as possible of his

dry clothing between them and the sufferer; and in this way endeavour to withdraw or raise and insulate the sufferer from contact with the earth. When insulated, the current will cease passing through him, and the cable, &c., may be withdrawn from contact with him. In doing so the rescuer must exercise great care that he does not place himself in a position to receive a shock.

14. Where a man is receiving a current through his person, by having placed one part of his person in contact with one portion and another part in contact with another portion of a cable, &c., thereby forming of his person a portion of the circuit, the most ready means of delivering him is by short circuiting such portion of the apparatus immediately outside the points of contact with the sufferer.

15. In cases where a man has received a serious shock, and life appears extinct, efforts similar to those employed in cases of drowning should be made to restore animation. Recent experience has shown that the system known as the "Laborde" system has been very successful. The treatment is as follows:—

16. Lay the patient on his back in the open air. Remove his neckcloth and unfasten his collar. Open his mouth, and, taking hold of the front part of the tongue with your fingers—either bare or covered by a handkerchief—very slowly draw the tongue forward, and as gently let it go back again 16 times a minute. Be sure that the root of the tongue is acted upon and drawn forward. Continue this action until signs of re-animation are observable, which should be the case in from 10 to 20 minutes. The motion thus imparted to the tongue should be regular and rhythmical in both its tractions and relaxations. If, in attempting to seize the tongue, it is found that the jaws are closed and the teeth clenched, open them by the finger, if possible, or, failing this, by a wedge-shaped piece of wood, the handle of a pocket-knife, or anything of the kind that may be at hand. Keep them wedged open.

17. The object of the traction effort on the tongue is to re-inflate the lungs, and by that means re-animate the body. The rescuers' efforts should not be relaxed at the first appearance of re-animation; those efforts must be continued until there is sufficient indication that this has been secured to such an extent as to ensure regular respiration by the patient without artificial aid. The patient should then be wrapped in such clothing as can be readily got together, capable of affording warmth, and removed to the nearest hospital, infirmary, &c., or to his own residence, if at hand, and placed in bed between blankets, with warm water bottles to his feet. A little brandy may be administered as soon as the patient is able to swallow, the object now being by warmth to promote the circulation of the blood.

18. Another system is as follows:—Lay the patient on his back in the open air. Remove his neckcloth and unfasten his shirt. Make a roll of clothing or anything else at hand, and place it under his shoulders. The roll must be sufficiently large to so support the spine as to allow the head to fall downwards and backwards. The patient's mouth should be opened and the tongue drawn out to free the throat. The rescuer, kneeling behind the patient's head, and facing him, should then grasp his elbows and drawn them well over the head of the sufferer so as to bring them almost together above it, and there hold them for some two seconds. He should then carry them down to the sides and front of the chest, firmly compressing it by throwing his weight upon them. After some two seconds the action should be repeated, and continued at the rate of 16 times per minute. Under this action the extension of the arms expands the chest walls, as in inspiration, or taking breath, and if the throat is clear, the air will rush into the lungs. When the arms are brought down to the sides of the chest, compressing it, the air is expelled, as in expiration. The action must be regular and rhythmical, and energetically and tirelessly persisted in until the breathing of the patient has again become normal. It is possible that this may not be assured in less than an hour.

19. If an assistant is at hand, both systems may be employed at the same time, the tongue being drawn out as the arms are raised, and allowed to go back as the arms are depressed, the combined action being as nearly as possible perfectly uniform.

20. The first opportunity should be taken advantage of by the services of any one within call, to obtain the presence of a medical man, who should, upon his arrival, be requested to take charge of the further treatment of the patient, the purpose of the foregoing instructions being to enable such restorative measures to be adopted as may be possible, pending the arrival of a qualified medical practitioner.

21. It is to be understood that, although there is to be no hesitation in shutting down any machinery, the movement of which for the time being may endanger life, it is important that the machinery should, especially where it is employed for the lighting of railway stations, thoroughfares, buildings, &c., made use of by the public, be set in motion again as rapidly as possible. It must not be forgotten that the sudden withdrawal of light from a busy passenger or goods station, or from rooms, offices, &c., may be attended with the most serious consequences, and for this reason no time must be lost, should occasion ever arise for suspending the light, in reinstating it.

S. B. COTTRELL,
Engineer and General Manager.

31, James Street, Liverpool,
November 1st, 1899.

Cleveland and Durham Power Scheme.—The Corporations of Middlesbrough, West Hartlepool, Stockton and Darlington, intend to oppose this company's Bill in Parliament.

THE BOARD OF TRADE INQUIRY re ELECTRICAL PRESSURE.

At the Westminster Town Hall on Friday last, Sir Courtenay Boyle presided, on behalf of the Board of Trade, over an inquiry held at the request of the Westminster Electric Supply Corporation and other electric lighting companies for the purpose of altering the Board of Trade regulations relating to the pressure at which current shall be supplied. The present regulation provides that no change shall be made in the pressure of the supply "except with the consent of the consumer." The alteration applied for was the substitution of the words "except on such terms and conditions as may be agreed upon between the undertakers and the consumers, or failing agreement, as may be settled by an arbitrator appointed by the Board of Trade," or words to that effect.

Mr. Balfour Browne, K.C., Mr. Roger Wallace, K.C., and Mr. D. Warmington appeared for the Westminster Electric Supply Corporation; Mr. Moon, K.C., on behalf of the Chelsea Electric and Metropolitan Electric Companies, Mr. Alfred Lyttleton and Mr. Talbot (London County Council), Mr. Danckwerts, K.C., and Mr. A. J. Walter (City Corporation), Mr. Littler, K.C., for the Windsor Hotel, Junior Constitutional Club and other consumers, and Mr. Roskill and Mr. A. B. Cane for the City of London Electric Lighting Company.

Mr. Balfour Browne, in opening the case for the Westminster Electric Supply Corporation, who he said were the promoters of the inquiry, said the object they sought was a modification of the proviso of Sec. 6 of the Board of Trade regulations. That company made an application to the Board of Trade in 1888 for an order to supply; at that time the Board of Trade held an inquiry as to the questions involved in the various applications that had been made to them, and one of the principles laid down by the late Major Mandarin in his report, which he believed had been acted upon ever since, was that competition as a general rule was in favour of the public, but that the best competition that the Board of Trade saw its way to sanction was competition by two companies supplying the public with energy, one high pressure, the other low pressure. An order was granted to the Westminster Company in 1899, and Sec. 10 provided that the energy was to be supplied by means of a system approved by the Board of Trade, and subject to such regulations and conditions for securing the safety of the public and for ensuring a proper and sufficient supply of energy as the Board of Trade might from time to time impose. In July, 1890, the Westminster Company submitted a system of supply to the Board of Trade, which system was sanctioned by the Board of Trade in September, 1890. The system was described as a low pressure continuous current system. In the same month the Board of Trade published their Regulations, and Sec. 10 of the Regulations was to this effect—during the whole of the period when a supply of energy is required to be provided by the undertakers in the distributing mains under the order it shall be maintained at a constant pressure so long as the pressure does not vary more than 2 per cent. from the standard pressure. Such standard pressure shall not be altered except by permission of the London County Council, and upon such terms and conditions as the London County Council may impose. That was put in for the express purpose of guarding the rights of the public, and it was practically a sufficient protection for the public. The regulation afterwards made by the Board of Trade was no protection to the public, and allowed one or two people to block and interrupt the supply of energy over a large district in London. The Westminster Company commenced the supply of energy in 1891, and they fixed their standard pressure at 100 volts. Their business had been an increasing one, and now they had 5,500 consumers taking 7 million units, and that large increase of business enabled the company greatly to reduce the price at which they sold. They began with a charge of 8d., and they gradually reduced the price until they got it down to 6d. for the first 4,000, and 4d. for every unit in excess of that number, or an average of 4·75 per unit, which was equal to only 59·4 per cent. of the authorised charges. In 1895 the Board of Trade decided to revise the regulations, and one of the chief points they had to consider was the allowance of the use of a higher voltage limit than 100 volts. There was a conference on the subject, and many of the existing regulations were revised and altered. The Board of Trade appointed a committee of experts, consisting of Lord Kelvin, Sir W. Preece, and Major Cardew, to whom this question of pressure, and also the question of Sec. 6, was referred. Of course, that was a private inquiry, and no evidence could be offered by the companies.

The President said he believed the commission only considered the question of high pressure.

Mr. Balfour Browne said that very likely Sir Courtenay Boyle was right. All that they knew was that the conference was adjourned, and that after the committee of experts had been appointed, the Board of Trade did alter the regulation to the form in which it stood at the present day. The form now was that before consenting to supply energy to any consumer the undertakers shall declare to such consumer the constant pressure at which they propose to supply the energy at his terminals . . . . "provided that no change shall be made in the pressure of supply to any premises which at the date of these regulations are supplied with energy by the undertakers except with the consent of the consumer." His company and a large number of local authorities were very apprehensive on that point, and they did not think all the facts could have been sufficiently before the Board of Trade at the time the regulation was made. When they began to supply they were advised by exceedingly competent engineers, and they were fully alive to the advantage of a 200-volt pressure, but at that time there

was no 200-volt lamp that could be depended upon, and on that competent advice they adopted the 100-volt pressure. In 1896, however, they were again advised by Prof. Kennedy and others, and they thought that the time had come to alter their pressure, and he maintained distinctly that that alteration was in the interests of the company, in the interests of the consumers, and in the interests of the local authorities. In order that they might make the alteration with the consent of their consumers they circularised their customers, and pointed out what in their opinion would be the advantage of the change. They had 5,500 consumers, and at the present day all of those 5,500 consumers were taking the 200-volt pressure with the exception of eight, and the most important of the eight were inspired in their objection by one gentleman. The position therefore was that they had to go on supplying eight customers, scattered over a large district, with energy at 100 volts, and that, of course, cost them a very considerable sum of money. They charged those eight customers the full price of 8d. per unit, but even then they supplied them at a loss. The eight objectors insisted that if the change was to be made in their premises from 100 to 200-volt, they should dictate what was to be done and what was to be paid. As he had said, at the present time they had satisfied the huge bulk of their consumers, and the change had been effected almost entirely at the expense of the company. It had cost them about £45,000 to make the conversion, but what the eight opponents seemed to desire was not that the conversion should be done in their case upon fair arbitration terms—which the company would be quite willing to arrange for—but they wanted to dictate what was to be paid to them for making the conversion. That the company objected to, and would resist.

The President: Have you offered these eight objectors arbitration terms at your expense?

Mr. Balfour Browne: No; I am informed that no such offer has been made, but if that is an advantage, I am prepared to offer arbitration terms. It was perfectly reasonable that if those gentlemen desired it some independent gentleman should say what the company should pay towards the expense of the new installation, but the question of the cost of the arbitration should be left to the arbitrator. What they pressed for was a change in the regulation, so that it should read "provided that no change shall be made in the pressure of supply to any premises which at the date of these Regulations are supplied with energy by the undertakers, except upon such terms and conditions as may be agreed upon between the undertakers and the consumer, or, failing agreement, as may be settled by an arbitrator appointed by the Board of Trade." The only objectors were, in the Mayfair district, the Junior Constitutional Club. There were one or two objectors in the Belgravia district, including the Duchess of Sutherland, who seemed to think that there was some danger from shock by the higher voltage. In the Westminster district the objectors included the Hotel Windsor, Messrs. Sellon & Cooper, and Prof. Forbes—the consumption of the two latter customers was 70 and 17 units respectively. Consumers who took the 200-volt pressure got a rebate of 8 per cent. on the original price. There was a more economical distribution of energy and a great saving in the loss in carrying the energy to the consumer. At the present time the loss was 12½ per cent., and that of course the consumers had to pay for. They would be able to reduce the loss to 5 per cent. if they got the regulation altered as they desired, and that would at once be a gain to the consumer. It was estimated that within the next 21 years there would be a saving of £157,000 in capital expenditure if they were enabled to supply everybody with the 200-volt current. Against that they would have to put the £45,000 which they had already paid out of capital on the conversion of the lamps, &c., so that the actual saving would be £112,000. The change would no doubt benefit the company, but it would be equally a benefit to the consumer. People thought at first that by using the higher pressure they would consume more electricity, but experience had shown that that was not the case. He believed that St. Pancras had adopted the 200-volt supply, but they were in the same difficulty as the Westminster Company, because they had to supply some consumers at 100-volt pressure. In Bradford the 200-volt system was carried out to the satisfaction of everybody, and the same was the case at Glasgow. The question was—why should a few people be allowed to block the way in such an important matter?

After some discussion on procedure, it was decided that the case of the Westminster Company should be taken first, but that as far as possible it should be confined to general questions.

Mr. Littler, K.C., who represented the consumers, and Mr. Danckwerts, for the City of London Electric Lighting Company, contended that the Board of Trade had no power to alter the regulations, as the privilege of supplying at 200 volts was a condition, precedent to the regulations, and therefore could not be altered with the consent of the people who were parties to the agreement and not by the Board of Trade.

Mr. Talbot said the companies were really seeking to take away from the consumers the advantages which the Board of Trade regulations gave them.

The President said he must decide that the Board of Trade had power to alter the regulations and the proviso, but whether it was expedient that they should do so was, of course, a matter for further argument.

Prof. Kennedy then gave evidence. He explained that at the commencement of its career the Westminster Company supplied current at 100 volts, but that in the year 1895 it became possible to get perfectly trustworthy lamps which would work safely at 200 volts, and it was then that he made up his mind that it would be a distinct advantage to use those lamps. It was in 1897 that the company commenced to make changes to the 200 volts. He thought it was a mistake to think that there was any danger to the consumer from shock on account of the higher voltage. Nor did he think the danger from fire was greater, because more pains were taken about the fittings and the installation generally. There was a great saving in the loss by transmission when a high voltage was used, as compared with a low voltage. Their distribution loss at first was about 12½ per cent., but if they could change the whole of their system to 200-volt pressure, they could go on with a very much lessened loss, and it would be 21 years before they again arrived at a loss of 12½ per cent. At first the loss would be reduced to about 4½ per cent., but it would gradually increase. There would be a very considerable capital saving, and that would be to the advantage of the statutory purchaser when the time came for the powers of purchase to be put in force. There would be a further advantage to the company, that they would not have to generate that 12½ per cent. of energy which was lost in transmission. The consumer had benefited by a reduction in price of 8 per cent., and they had given them new lamps for old. He did not think that since 1897 there had been any electric undertaking of any importance in which lamps of a less voltage than 200 had been used.

By the President: He did not think that there was any greater eating away of the insulated material in a 200-volt system, than there was in the case of a lower voltage, provided that proper material was put in.

Mr. James Heald, chairman of the Electric Lighting Committee of Lancaster, gave evidence to the effect that in the borough they felt the need of a change to 200 volts, and therefore they supported the application for the alteration of the regulation.

Evidence was also given on behalf of the Glasgow Corporation by Mr. Chamen, the city electrical engineer, who said that they had changed their pressure from 100 volts to 150, 200 and 250, and there were only about half a dozen consumers who objected.

The inquiry was then adjourned until Thursday.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS, 1901.

Compiled expressly for this journal by W. P. Thompson & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, Manchester and Birmingham, to whom all inquiries should be addressed.

3,429. "Improvement in ducts of stoneware, clay, concrete or other plastic material for carrying electric or other cables for light, power, traction, telegraphs, telephones, &c." W. Garnett. February 18th.

3,434. "Improvement in electrical switches." M. Mercier and W. O. Andrews. February 18th.

3,438. "An apparatus for recording the time an electric car passes a station." C. J. Spencer. February 18th.

3,450. "Improvements in accumulator plates." B. M. Drake and J. M. Gorham. February 18th.

3,451. "Improvements in the electrolytic break." M. A. Codd. February 19th.

3,468. "Improvements in or appertaining to electric alarm clocks." S. Paulsen. February 18th.

3,481. "Improvements in apparatus for wireless telegraphy." J. A. Fleming and Marconi's Wireless Telegraph Company, Limited. February 18th.

3,487. "Improvements in or connected with the carrying of strikers upon motor vehicles for mechanically operating electric switches." W. Kingsland. February 18th.

3,488. "Improvements in or connected with electric ignition apparatus particularly applicable to explosive engines." F. F. Wellington. February 18th.

3,491. "Improvements in arc lamps." J. A. Rignon, T. L. Carbone and A. Moreno. February 18th. (Complete.)

3,493. "Improvements in the method for obtaining electric currents from the earth." E. Jahr. February 18th. (Complete.)

3,494. "Improvements in electrical glow lamps." A. Couch. February 18th. (Complete.)

3,526. "An electrically lit watch or clock case." H. V. Manger. February 19th. (Complete.)

3,540. "Process of simultaneous and separate extraction of hydrogen and oxygen gases from the body water by electrolysis." C. De Ricaris. February 19th.

3,554. "Improvements in and connected with apparatus for transmitting and receiving electro-magnetic waves or impulses." J. T. Armstrong and A. Orling. February 19th.

3,563. "Improvements relating to electro-magnetic driving mechanism." J. Soulat. February 19th.

3,576. "Improvements in electric switches." P. H. F. Spies and J. Norden. February 19th. (Complete.)

3,613. "Improvements in and relating to electric percussive rock drills or the like." A. M. Barnes. February 19th.

3,636. "Improvements in devices for connecting electrical circuits to earth in case of emergency chiefly for use with overhead wires." E. M. Hollingsworth. February 20th.

3,660. "New or improved automatic guard for electric street cars." A. Koniqslow and C. Pilgrim. February 20th.

3,669. "Magnetic toy." E. A. Falconer. February 20th.

3,679. "Improvements in electric switches." F. H. Headley. February 20th.

3,686. "Improvements in electrical switches." W. H. F. Murdoch. February 20th.

3,694. "Improvements in adjusting head rods for split switches." H. Birkbeck. (E. Bristol, Canada.) February 20th.

3,699. "Improvements in trolley heads for use in connection with overhead systems of electrical traction." J. A. Orme. February 20th.

3,710. "Improvements in or connected with the regulation and starting of single-phase and polyphase alternate current motors with magnetic rotating fields." P. J. M. Girault. February 20th.

3,713. "An improvement in electrolytic breaks." E. H. Howlett. February 21st.

3,744. "Improvements in means for protecting or guarding overhead electric trolley or the like electric wires." E. QUARMBY and E. A. NORTH. February 21st.

3,753. "Improvements in connections for electric conductors." J. D. F. ANDREWS. February 21st.

3,793. "A new and improved compound or material for insulating electrical wires." H. W. WEBB. February 21st.

3,794. "A new and improved die or mandrel and mounting therefor for facilitating the uniform coating of electrical wires with insulating material in a viscid state." H. W. WEBB. February 21st.

3,796. "Improvements in surface contact electric traction systems." W. AITKEN. February 22nd.

3,799. "An improved method and apparatus for the prevention of accidents from trolley wires." R. C. QUIN. February 22nd.

3,803. "Improvements in electrically illuminated letters for signboards." G. SMITH and H. H. HALL. February 22nd.

3,823. "Improvements in and connected with conduits for electric wires and cables." R. AMES. February 22nd

3,829. "Improved steadying resistance for Nernst lamps." C. C. GARRARD and the NERNST ELECTRIC LIGHT, LIMITED. February 22nd.

3,833. "Improvements in Nernst lamps." B. M. DRAKE, C. C. GARRARD, E. G. SHEPPARD, M. SOLOMON and the NERNST ELECTRIC LIGHT, LTD. February 22nd.

3,834. "Improved means for starting electromotors with rotating fields." P. J. M. GIRAULT. February 22nd.

3,860. "Improvements in electro-magnets." E. G. SHEPPARD, M. SOLOMON, and NERNST ELECTRIC LIGHT, LTD. February 22nd.

3,881. "Improvements relating to overhead conductor electrical traction systems." C. F. ELLIOTT. February 23rd.

3,923. "Improvements in tramway switch operating mechanism." F. A. CARROLL. February 23rd (Complete.)

3,929. "Improvements in or relating to electric lamps." E. ANDREAS. February 23rd.

3,930. "Improvement in the art of telephony." O. LUGO and J. A. BARRATT. February 23rd.

3,933. "Improvements in and relating to means for heating the ironing roller or rollers, or ironing machines by electricity." F. H. HEADLEY and C. HART. February 23rd.

3,935. "Improvements in or in connection with the laying of underground conductors for distribution of electrical energy." F. JONES. February 23rd.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson and Co., 322, High Holborn, W.C., and at Liverpool, Manchester and Birmingham, price, post free, 9d. (in stamps).

1899.

6,992. "Improvements in switching contrivances for two electric incandescent lamps connected up together." W. Schiesser and H. Moore. Dated April 1st, 1899. A key switch is fitted on one of a pair of lamps, and the contacts and connections are so arranged that only one of the pair can be alight at one time. The lamp carrying the controlling switch may be in front of a loom, and the lamp at the back. The switch comprises a drum carrying contact faces with which engage contact springs. The contacts on the drum are so arranged that, on successively turning the key a quarter turn, the lamp is first alight, then the lamp next the lamp again, and lastly the circuit is broken with both lamps extinguished. By modifying the connections both lamps may be alight when the drum is in one position. 8 claims.

7,015. "Improvements in telegraphing by means of sound waves." S. A. Varley. Dated April 1st, 1899. Signals, bells, siren, whistle, &c.; signals, receiving apparatus for speaking tubes. Relates to means for signalling or communicating by means of sound waves. The apparatus serves both as a transmitter and a receiver, and consists of a parabolic trumpet adjustably mounted on pivots. When a message is spoken into the focus of one trumpet, the sound is reflected to the trumpet at the receiving station, and is heard in the focus of the latter. The trumpets may be mounted on suitable poles or towers, and connected to speaking-tubes through which the communications are transmitted and received at lower levels. For longer distances, the tubes are connected to a chamber which communicates with a larger chamber containing audible signalling apparatus, such as bells, sirens, whistles, &c., of definite pitch. The receiving apparatus contains a tuning fork, &c., constructed to synchronise with the signals received, and is put in communication with the chamber through the cock. The tuning fork responds to the signals received, and actuates the microphone, which, through the induction coil and the ordinary telegraph relay actuates the Morse telegraph instrument in the usual way. 2 claims.

7,041. "Improvements in electric arc lamps." G. St. J. Day. Dated April 4th, 1899. Arc lamps. Carbon electrodes are formed so that they can be arranged concentrically. A round, hexagonal, or fluted rod or tube may be placed within a larger hollow carbon of corresponding form, or the outer electrode may consist of two half cylinders; a third concentric electrode may be used. The free end of the inner electrode may be enlarged. The carbons may be fixed, and the arc struck at their free ends by applying a piece of carbon carried by a rod. Or the inner carbon may be carried by an insulated holder movable about a pivot by a series electro-magnet acting in opposition to a spring to strike an arc. The outer carbon may be similarly movable. The fixed ends of the carbons may be separated by an insulator, or notched, or otherwise formed, to cause extinction of the arc before the carbons burn out entirely. 1 claim.

7,144. "A new or improved electric apparatus for automatically regulating the physical condition, such as heat, pressure, pygrometric state, and density of gases and liquids." H. Schultz. Dated April 5th, 1899. Relates to electric apparatus for automatically regulating the condition of gases and liquids in respect to heat, pressure, vacuum, density, or humidity, either to maintain the state at a predetermined degree, or to increase or reduce it. The temperature in the chamber is kept constant by the operation of the slide valve which controls the admission of the cold and hot fluids by way of the ports, the valve being operated by the hydraulic piston which is worked by the relay and battery, the movements being due initially to the metal thermometer. The hand of the regulator is controlled by the clock and the hand by the thermometer through the medium of the segment and pinion and the electro-magnets excited through contacts. By turning the curved disc, one of the two clicks actuated by electro-magnets is made to engage with the ratchet wheel through the intermediary of which the movement of the contact hand is being controlled. When the hands meet, the slide-valve mechanism is set in motion Contact rails are provided to impart the desired motion to the hands so that the regulator may have eight times the speed of the regulator. By omitting the timepiece and contact rails the apparatus may be used as a thermostat. When employed in connection with a malt-drying installation, the apparatus may be used uniformly and gradually to raise the temperature to a given maximum temperature. The apparatus may also in conjunction with a pressure gauge, be employed for regulating the supply of fuel in coal-dust furnaces. 5 claims.

7,364. "Improvements in dynamometers." G. J. Gibbs. Dated April 7th, 1899. Power is transmitted from the pulley to the shaft, or *vice versâ*, by means of springs connecting the pulley to the dics, which is fixed to the shaft. The distortion of the springs, due to varying power, may be either graphically recorded or may be integrated with respect to time. A tracing point is spring mounted on the pulley and presses upon a paper strip which is carried by drums mounted on a bracket secured to the disc. The feed of the paper is effected by worm wheels engaging worms on a shaft which is rotated by the engagement of a crown wheel with a worm. The worm is held stationary by the engagement of a pin with a fixed part of the apparatus, but it may be freed, to stop the feed when desired. In the integrating arrangement, the shaft carries a disc on which a wheel is pressed at a point more or less distant from the centre according to the rotation displacement of the pulley and disc. The sliding shaft carrying the disc is thus rotated more or less rapidly as the power increases or decreases, and actuates a counter accordingly. 5 claims.

7,370. "Improvements in and connected with the control of electrically-propelled vehicles and trains." H. M. Leigh. (F. J. Sprague.) Dated April 7th, 1899. Relates to the "multiple unit" system of controlling electrically-driven trains from any desired point on the train, which may be built up in vehicles arranged in any order and any or all of them carrying one or more driving motors or none at all. The master or driver's controllers at each end of the car are connected by local wires to each other and to the motor controllers and to the train wires which are carried through the whole length of the train by proper couplings. These connections are made by plug switches with the requisite number of the plugs, the last one making the connection with the supply wire which couples at 11 the connecting shoes on the train. Another switch worked by hand, cuts out the motor connections. The motor controller consists of a rheostat cylinder driven by a pilot motor, independent series-multiple switch, and reversing switch operated by solenoids, throttles, and a switch which limits the operations of the pilot motor and the solenoids. The latter switch is in one with or works in conjunction with the main motor rheostat. The general arrangement is such that the main motors are put into series or multiple by manipulating any one of the driver's switches. In passing from the series to multiple position, the circuit is opened and a shunt to the field of a series motor holds the field and reduces the arc. 8 claims.

7,415. "Improvements in electrical cooking apparatus." J. B. Cary and H. C. V. Delevy. Dated April 8th, 1899. A cooking apparatus consists of two metal boxes connected by slotted hinges, screws, and clamping nuts, so that they may be held in contact, or one at some distance above the other. Each box is closed by a sliding corrugated enamelled iron plate which extends forward to convey drippings to a separate receptacle; the enclosed space contains iron heating wires clamped between insulating strips or incandescent lamps. With the boxes in contact, a steak may be cooked between the corrugated plates. When the boxes are separated, a rectangular shield may be placed between the corrugated plates, to form an oven; the shield carries a spit provided with a toothed wheel engaging a spring pawl, to retain it in any position to which it is turned by a handle. 3 claims.

7,427. "A rotary converter or transformer for simple or polyphase alternating electric currents." J. Imray. (La Societe Anonyme pour la Transmission de la force par L'Electricite.) Dated April 8th, 1899. Relates to a converter or transformer for converting simple or alternating currents. The two armatures preferably Gramme rings, are mounted on one shaft. The one ring rotates within an inductor of an asynchronous motor supplied with alternating current. The other ring rotates between field magnets in the polar extensions of which are fitted rings connected by copper bars. The sections of the first ring are connected to the sections of the second ring, and to the commutator symmetrically. The continuous current is taken off by the brushes. 1 claim.

7,523. "An improved clip for shades for electric lamps, candles, or other illuminating devices." E. Dunand. Dated April 10th, 1899. A clip for supporting a silk, paper or like shade is provided with an outer ring, which is separated by an air space from the clip, and carries the shade, to avoid the overheating of the shade. The outer ring may be supported on the clip by non-conducting material or in any suitable manner. In one form the outer ring is formed by parts of the clip, and the connecting-parts and jaws are perforated. The invention is applicable to electric or other lamps or candles. 1 claim.

7,525. "Improvements in telegraphic transmitting, receiving, and translating arrangements." A. Muirhead. Dated April 10th, 1899. Relates to arrangements in connection with submarine telegraphy for transmitting, receiving, and translating either in single or duplex working. The specification describes a number of modifications for obviating a shifting zero, employing and regulating curb currents, and the use of "out-flow" and "overflow" currents in connection with the artificial line for regulating and sharpening the signals in translating from one circuit to another. Relay contacts are rendered more certain and less cohesive by the use of rotating contact discs such as described in Specification No. 1,867, A.D. 1886, such discs being in some cases sub-divided or formed of insulated conducting sections, which sections may be connected by resistance coils. In some forms the contact may be a vibrating plate instead of a rotating disc. The swing coils connected to or carrying the contact lever may also be kept in a state of vibration by means of an apparatus as described in Specification No. 11,069, A.D. 1894, and to the automatic curbing key described in Specification No. 1,784, A.D. 1865. 12 claims.

7,577. "A new or improved method and apparatus for operating contacts for electric traction." A. Ballance and S. A. Jefferson. Dated April 11th, 1899. Electric railways and tramways on a road contact system with mechanically operated switches. Conductors, switches. Plungers projecting into a continuously grooved plate in the roadway are alternately depressed by rollers at opposite ends of the vehicle and act through the rock shaft and arms to raise and then lower the plungers into the path of the collector. Contacts on these plungers complete the circuit to the mains at the spring contacts and a spring acting on a roller mounted on the underside of the rock shaft holds it in either position. The switch box is divided by partitions and closed by a cover. Glands around the conductors, plungers, and shaft keep the switch compartments water-tight. Rollers are eccentrically mounted at the ends of the vehicle, so that they may be turned to run in either of the grooves. 4 claims.

7,584. "Improvements in electric switches and cut-outs." Crompton & Co., Limited, and H. W. Wartnaby. Dated April 11th, 1899. In magnetic cut-outs, the electro-magnet controlling the catch of the switch lever is placed in a shunt circuit instead of in series. 1 claim.

7,618. "Electrical apparatus for diminishing the apparent self-induction of alternating current circuits, and capable of being used in lieu of condensers." C. D. Abel. (La Societe Anonyme pour la Transmission de la Force par L'electricite.) Dated April 11th, 1899. Relates to apparatus for diminishing self-induction applicable in lieu of condensers. If a coil, suitably proportioned, through which the alternating current passes is suspended in a constant magnetic field, it acts similarly to a condenser. A suitable construction of apparatus consists of two grooved pieces of steel fitted together so as to leave an annular space for the reception of a magnetising coil. A copper disc having downwardly-inclined edges dipping in a mercury trough is pivoted at its centre, and connected to one of the circuit terminals. A fixed copper disc is arranged above, and also dips in the mercury trough. It is connected to the other circuit terminal. A continuous current dynamo, in which the induced part can oscillate freely, can be used for the same purpose. The apparatus is especially useful with synchronous machines for reducing the apparent self-induction. 2 claims.

7,641 "Improvements in Hertzian wave telegraphy to enable signals to be transmitted to any distance by means of intermediate relay stations." P. H. Cole and B. Cohen. Dated April 11th, 1899. Relates to intermediate stations by which Hertzian signals are received from one section and retransmitted on to the next. The apparatus can receiver or transmit in either direction. Two vertical rods are separated by a metallic screen and are attached to the tongues of two main relays. The tongues are attached to, but insulated from, two other tongues connected in the primary circuit of the induction coil, the two coherers and the two subsidiary relays, are arranged so that the first subsidiary relay controls the first main relay and the second subsidiary relay the second main relay decoherers are arranged in circuit with the primary of the induction coil. The armatures of main relays may have finger knobs so as to facilitate initial transmission from the intermediate station. 2 claims.

8,168. "Improvements in mounting incandescent electric lamp bulbs." H. Moul and A. Sind. Dated April 18th, 1899. Incandescent lamps.—For connecting a bulb to a cap of any description, the bulb neck is blown in a mould, which forms one or more depressions to receive tongues bent in from the cap. The depressions are filled with plaster or other cement. 1 claim.